THE

ELECTRICAL REVIEW.

VOL. XXXVI. MAY 10, 1895. No. 911.

CONTENTS:

	PAGE
The Economical Use of the Incandescent Lamp...	569
The Chemnitz Central Station (*illustrated*)	572
On the Blackening of Incandescent Lamps	575
Electrical Heating	575
Electrical Treatment for the Sick Poor	576
The Demand for Electrical Engineers	577
The Royal Society Conversazione	577
Waves and Vibrations.—VI.	578
The Telephone Service: Parliamentary Inquiry	579
Indecent Wiring (*illustrated*)	582
New Departure (!) in Electric Lighting (*illustrated*)	583
Correspondence:—*Lightning* and the St. Pancras Explosions ...	585
Gas *v.* Steam Engines	585
An Interesting Question	585
British Thomson-Houston *v.* Raworth	586
A Protest...	586
Business Notices, &c.	586
Electric Lighting Notes	587
Electric Traction and Motive Power Notes	588
Telegraph and Telephone Notes	588
Contracts Open and Closed	589
Books Received	590
Notes	590
City Notes	592
Traffic Receipts	592
Share List of Electrical Companies	593
Tests of Glow Lamps, and Description of the Measuring Instruments Employed (*illustrated*) (*continued*)	594
Proceedings of Societies:—	
The Institution of Electrical Engineers (*illustrated*) ...	596
Physical Society...	599
New Patents	599
Abstracts of Published Specifications	600

THE
UNIVERSAL ELECTRICAL DIRECTORY
(J. A. BERLY'S).

PRICE 4/- POST FREE.
The Leading Electrical Trades Directory and the Oldest Electrical Directory in the World.

1895 ISSUE
READY.

PRICE 4/- POST FREE.
Fully Revised and Thoroughly Reliable.
Contains a larger amount of Trade Matter than any other Electrical Directory.

H. ALABASTER, GATEHOUSE & CO.,
22, Paternoster Row, London, E.C.

THE ELECTRICAL REVIEW.

Published every FRIDAY, Price 4d.

The Oldest Weekly Electrical Paper. Established 1872.

TO BE OBTAINED BY ORDER FROM ANY NEWSAGENT IN TOWN OR COUNTRY.

OFFICE:—22, PATERNOSTER ROW, LONDON.

Telegraphic Address: "AGREKAY, LONDON." Code A B C. Telephone No. 517.

ALL Letters should be addressed to the Proprietors, H. Alabaster, Gatehouse & Co.

ADVERTISEMENT RATES ON APPLICATION.

The "Electrical Review" is the recognised medium of the Electrical Trades.

SUBSCRIPTION RATES.—In *Great Britain*, Post Free per Year, 19s. 6d. To all *other Countries*, per Year, £1 4s.

BINDING.—Subscribers' numbers bound, including case, for 4s. each volume.

CASES.—Cloth Cases for Binding can be had, price 2s. 6d. each.

FOREIGN AGENTS.—*New York:* D. VAN NOSTRAND, 23, Murray Street. *Paris:* VEUVE J. BOYVEAU, 22, Rue de la Banque. *Berlin:* ASHER & Co., 5, Unter den Linden.

Cheques and Postal Orders (on Chief Office, London) to be made payable to H. ALABASTER, 22, Paternoster Row, E.C.

THE ECONOMICAL USE OF THE INCANDESCENT LAMP.

THE paper on glow lamps tests by Prof. Ayrton and Mr. E. A. Medley appearing in the current number of the *Philosophical Magazine*, and which we commenced in our last issue, deserves the careful attention of those interested in electric lighting. The authors describe elaborate experiments which they have made to determine under what conditions the incandescent lamp gives its light at a minimum total cost including lamp renewals and power. The investigation was principally directed, firstly, to determine what effect was produced on the cost by varying the voltage at which current was supplied to the lamps, and secondly to discover whether there was what is called in America "a smashing point," *i.e.*, a certain point where economy demands that an old lamp should be destroyed and replaced by a new one.

These important questions can only be answered by ascertaining the complete life history of each class of lamps in terms of candles per watt, or some equivalent factors, at each moment of the life of the lamp. A number of such investigations have already been made on this subject. Feldman, in 1892, drew up a table derived from tests of American and European lamps made by Prof. Thomas and Messrs. Martin and Hassler in America, and by Haubtmann in France. When these results were plotted out as curves in terms of candle-power and time, they showed a remarkable falling off in the candle-power as the lamps got older; the decrease in candle-power, in fact, varied from 40 to 65 per cent. in 1,200 hours.

The authors of the paper deduce some interesting and important conclusions from the figures given in Feldman's tables. Since the total cost per hour per candle in a lamp is made up of two parts, viz., the cost of renewals and the cost of power, it may be found by adding the price of the lamp divided by the product of the life in hours and the candle-power, to the product of the watts per candle by the price of one watt hour. It is evident that both that part of the cost due to renewals, and that due to the price of power will be very materially modified by a falling off of 40 to 65 per cent. in the candle-power during the life of the lamp; for the average candle-power will be considerably less than the initial maximum, and the average watts per candle-power will be considerably greater than the initial minimum. In fact, it can be readily imagined that the efficiency of the filament as a light producer may become so low as the lamp gets older, that a saving may be effected by buying a newer and more efficient lamp. To ascertain when this "smashing point" occurs, curves were plotted out in terms of total cost per hour per candle-power, and time; by inspection of these curves it can easily be seen at what time in the life of the lamp the cost is a minimum. The shape of the curves varies

with different prices of lamps, and with different costs of power. When lamps of the Feldman type cost 1s. each, and power costs 4½d. per Board of Trade unit, the total cost of the light is least when they are used for 600 hours only. A change of price in the lamps does not much affect the "smashing point," but a change of the price of the Board of Trade unit to 9d. reduces the economic life of the lamp from 600 to 430 hours.

The lamps tested by Prof. Ayrton and Mr. Medley were of the Edison-Swan type manufactured in this country. The results of these tests show that the life history of the Edison-Swan lamps, in some cases at least, differs materially from that of the American and European lamps already mentioned. Not only was there no falling off from the initial candle-power, but a very considerable increase took place in the early part of the life of the lamp. For example, in 8-candle lamps run at 100 volts, the candle-power increased by 33 per cent. in the first 124 hours. The current at the same time increased, but only by 5·87 per cent., so that the watts per candle-power dropped from 4·79 to 3·82. The candle-power during the whole life of one of these lamps never fell below the candle-power at starting.

The economical use of these Edison-Swan lamps must therefore differ materially from that of the American and European lamps tabulated by Feldman. As there is no marked decrease of their candle-power before they break down, there will be no "smashing point," *i.e.*, there is no point at which it will be economical to replace old lamps by new. These tests have revealed a fact of the greatest importance in electric lighting. Whether it is due to a difference in the material used for the filament, or in the method of manufacture, there exists such an essential difference between the lamps of different makers, that they must be used in quite a different way to produce light at the least cost. Later tests made by the authors with another batch of Edison-Swan lamps showed that even the lamps of the same maker exhibit a considerable difference in their life history.

Incidentally these experiments showed that the usual estimate of the candle-power and watts of an 8-candle 100-volt Edison-Swan lamp is very much too low. The specimens of this lamp tested were found to give an average illumination during their whole lives of about 10 candles, and to absorb an average power of 4·3 watts per candle, so that such a lamp must be regarded as a 43-watt lamp, and therefore takes about 43 per cent. more power than is usually stated. This, of course, has an important bearing on the design of dynamos. The current required for a given number of lamps will be 44 per cent. greater, and the heating of the dynamo 108 per cent. greater than is usually estimated.

The authors have drawn cost curves with the data obtained from these new tests. In one set of curves the price of the kilowatt hour has been taken at 4½d., and in another at 9d., the cost of the lamp being taken in both cases at 1s. 9d. To test the effect of varying the voltage, curves were drawn from the data furnished by tests made at 100, 101, 102, and 104 volts. The curves for which the price of the Board of Trade unit was taken at 4½d. did not turn up at any point, *i.e.*, there was no time before the natural end of the life of the lamp when it would have been profitable to discard it. In the curves obtained with the Board of Trade unit at 9d. there is some slight evidence of turning up, but in no case is there sufficient rise to justify the discarding of the lamp before it breaks down. It was impossible to say which voltage was the most economical, owing to individual variations among the lamps. The two conclusions at which the authors arrive by the study of the total cost curves are:—1. The modern Edison-Swan 8 C.P. 100-volt lamps, such as were tested, should not be discarded till the filaments break. 2. No marked economy can be gained by overrunning this type of lamp.

What is the cause of this remarkable increase of candle-power and efficiency observed in some of the modern Edison-Swan lamps? It was suggested by Mr. Howell that it was due to an improvement in the vacuum produced by the action of the incandescent filament on the residual gases. The authors applied the induction coil vacuum test, and found that in every case the vacuum did improve; but tests with some more recent Edison-Swan lamps showed that there was an improvement of the vacuum without any corresponding increase in the candle-power. The improvement in the vacuum could not therefore be the sole cause of the improvement in the candle-power. Prof. Ayrton considers that it is due to some change in the surface of the filament which reduces its emissive power for heat, and consequently increases the emission of light.

We have seen what material differences have been found to exist between the lamps of different makers, but even among lamps supplied by the same maker, there appears to be a great want of uniformity. A new batch of Edison-Swan lamps tested by Prof. Ayrton and Mr. Medley in January of this year did not show the great initial increase of candle-power exhibited by those employed in the previous tests. The existence of such differences even in lamps issued by the same makers, makes it impossible to lay down any simple rule for the best potential difference or length of life for any lamp when we rely only on the maker's mark. The only safe way is to ascertain by a special experiment the life history of a sample from each batch of lamps. The authors, however, conclude that the best approximation is obtained by employing a potential difference which will cause the lamp during a large portion of its life to have an efficiency of about 0·25 candle per watt, which corresponds with 4 watts per candle.

The want of uniformity, not only among lamps produced by different manufacturers, but even, though to a less extent, among lamps of the same brand by the same maker, is not the least important of the facts ascertained by this investigation of Prof. Ayrton and Mr. Medley. This is a direction in which an improvement is wanted. This investigation ought to be of the greatest practical importance to lamp makers as well as to users. The tests have been made with such a refinement of accuracy, that the utmost reliance may be placed on the results. They point to the solution of many interesting problems in connection with lighting by the incandescent lamp. It would appear from some of the results that a lamp with a brilliant, though short career, may be quite as economical to the consumer as a long-lived lamp, and it would undoubtedly be to the interest of the manufacturer to produce such a lamp. If it is impossible for the manufacturers of incandescent lamps to secure practical uniformity in the same type of lamp, it

would certainly be advisable that such data should be supplied with each batch as will enable electrical engineers to determine how they are to be used to obtain light at the least cost.

Our Social Status.

An individual, who was described as a gentleman, and who lives at Connaught Place, Hyde Park, was brought up at Bow Street on the 2nd inst. charged with being disorderly, and with assault. A solicitor who attended on his behalf expressed sorrow for what had occurred, and stated that "the prisoner was not a gentleman; he was an electrical engineer"! This reminds us of a well-known incident in which a lady member of the upper ten and a distinguished member of the fourth estate were concerned. The latter had been introduced to the former at a brilliant social function. "Who is the gentleman you were chatting with?" inquired the lady's mamma. "Oh, he is not a gentlemen; he is a press man," was the answer—overheard by the latter. Perhaps it may be admitted that electrical engineers do not *always* behave as gentlemen. A former President of our Institution was on one occasion referred to as something very different. "Go and ask the lecturer," said one press man to another; "no doubt he will clear up your difficulty." "Well," said the one to the other a few minutes afterwards, "Did the lecturer put you right?" "He!" exclaimed press man number two, "He's a pig!" With some people in this country, a "gentleman" is a male person who does no work, or who "keeps a gig."

A New Application of Electricity to Chemistry.

THE science of chemistry is becoming daily more indebted to the sister science of electricity for the elucidation of obscure problems as well as for assistance in commercial processes. Chemists are always endeavouring to satisfy themselves respecting the constitution of the myriads of compounds which are now known to exist. The immediate good is that additions are made to the sum total of knowledge though the practical advantages may appear to be remote. However, such is the method of modern chemists, and that it is a praiseworthy one nobody will deny. In many cases the ordinary resources of chemistry completely fail, hence chemists have been driven to seek aid from physicists. Already the determination of some of the physical constants of certain substances is sufficient to identify them. Great assistance has been experienced in fixing the constitution of compounds by means of an estimation of their molecular conductivity. A. Werner and A. Miolati have recently divided inorganic compounds into four groups, namely, those in which the complex group is united with one, two, three, or four univalent ions respectively. In the *Zeitschrift für Physikalische Chemie*, xiv., p. 506, may be found a paper by these authors in which the results of their system of elucidating chemical constitution by molecular conductivity determinations are given. The conductivities of a large number of compounds are recorded and in a few cases depicted graphically.

The Latest Product of the Electric Furnace.

THERE is a curious anomaly in the history of electric smelting for which it would be hard to find an exact parallel; it became a commercial process almost before the pure scientists were aware of its existence; however, it is now being studied by numerous observers, and is yielding results of a most interesting nature. We have already alluded to the production of calcium carbide and its possible influence on the coal gas monopoly; and to the production of silicon carbide (carborundum). Both these substances appear likely to give rise to important industries; for to take the latter, for example, the Niagara Falls Power Company has recently secured a contract with the Carborundum Company to supply 10,000 electrical horse-power. The French chemist, Moissan, again says that, at the enormously high temperatures which it is possible only to obtain in furnaces in which the heat of the electric arc is utilised, practically all those metals which are with difficulty reducible — vanadium, chromium, molybdenum, tungsten, uranium, the metals of the alkaline earths, &c.— may be oxidised by carbon, and obtained in the pure state. His latest synthesis is crystalline carbide of aluminium. This he accomplished as follows :—A number of carbon cells, each charged with 15—20 grammes of aluminium, were placed in the carbon tube of the furnace and submitted to the action of a current of 300 amperes, 65 volts, hydrogen gas being passed through the tube during the operation and until the apparatus became cold. The grey fused mass formed in the cells when fractured was found to be interspersed with brilliant yellow crystals of the new compound carbide of aluminium. Similar crystals were also obtained by electrolysing a mixture of kaolin and carbon. Whatever the practical significance of this latest product of the electric furnace may be, it is certain that the work of such men as Moissan, Acheson, Willson, not to omit the brothers Cowles, suggests great scope for research. It opens up a wide and hitherto almost unexplored field for chemical discovery which may eventually lead to applications of the greatest industrial value.

The Magnetic Properties of Iron.

THE question whether the magnetic properties of iron are called into action under extremely rapid alternations of the magnetising forces must now be answered in the affirmative; since the matter is quite clear if we take two recent papers by Prof. John Trowbridge and Mr. C. E. St. John, in the *American Journal of Science*, into consideration. The question was approached by these two scientists from entirely different standpoints: yet they arrived at results which are identically the same. Prof. Trowbridge chose the well-known method which has been used for determining the "damping" of electric waves on iron wires, whilst Mr. St. John used a Lecher wire combination which was deprived of the secondary discs near the vibrator plates which complicate the Hertzian wave system, and a special arrangement was adopted which enabled the observer to adjust the length of the wires at will. Prof. Trowbridge found that the wave lengths sent out by a vibrator on iron wires differ in length from those transmitted along copper wires of the same geometrical form: whilst Mr. St. John confirmed the observation and assigned as a cause the increased self-induction due to the magnetic properties of the iron. This implies, he says, arguing from his figures, that the magnetisation of iron can be reversed 115,000,000 times per second. If this be true it reduces the "time lag" of magnetisation to within very narrow limits, if forces of such duration can magnetise the iron.

The Evils of Electric Lighting.

THE examples of the jerry wirer, which we publish in another column, make it imperative that some stringent measures ought to be at once decided upon. We fully recognise the difficulties of taking concerted action, but the question of bad work has become so acute that adequate remedies are immediately necessary. The fire offices are too much imbued with the spirit of *laissez faire* for us to expect much from them, and, after all, the responsibilities of a fire office are limited. It is satisfactory to find the Institution of Electrical Engineers is really alive to the necessity of providing some rules that can be understood, but neither the rules of Fire Offices nor of the Electrical Engineers are likely to affect the abandoned wretch who puts in cotton covered or uncovered wire. In the first place the majority of fire offices do not make inspections and would be no wiser if they did; and, in the second place, the Institution have, unfortunately, no power to compel a person to work to a proper standard. What is wanted is a stringent inspection and strict supervision, and to this end the efforts of electrical men should be mainly directed.

THE CHEMNITZ CENTRAL STATION.

THE Corporation of Chemnitz were considering in the spring of 1892 the construction of a central station, and after negotiations with several firms, in 1893 came into closer relations with Messrs. Siemens & Halske. After a short delay his firm concluded a contract, by which the whole electric ighting plant was to be laid down by Siemens & Halske at the cost of the town, and was to be worked by the contractors under a guarantee for interest and depreciation; the town also has a share in the net profits.

The buildings were begun at the end of August, 1893, and were pushed on so fast, that by the end of May, 1894, the regular supply of current had begun, and after a short trial, the beginning of the maintenance contract was fixed for July 1st, 1894.

In consequence of the special circumstances of the case, the three-phase system, with one step-down, was adopted; since not only had the current to be conveyed some distance, but it had to be used largely for motors, as well as for lighting. The site for the central station was a piece of ground on the northern boundary of the town, at the confluence of two streams, and its size was so selected, as to allow of very considerable extensions. Parallel to one of the streams, on the east front of the engine house, there is an underground canal, which brings the necessary water for the boilers and for the condensers to a well. In case of dearth of water in this well, water can also be taken directly from the streams. Besides which there is direct connection with the town water supply. Two Worthington pumps, each capable of delivering 1,100 gallons per hour, supply the feed-water to the boilers, either directly from the well, or through a tank. All the supply pipes are duplicated.

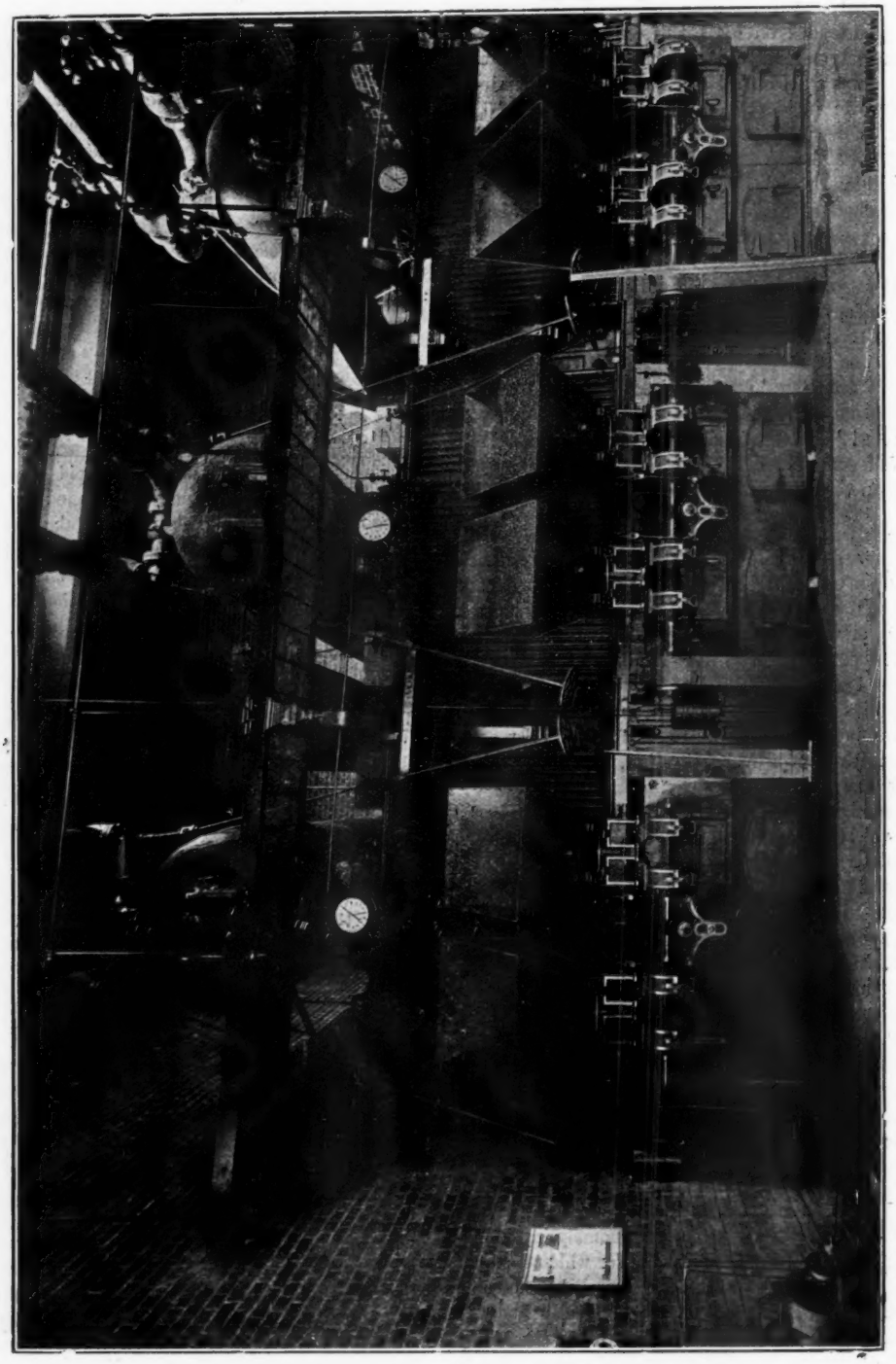


FIG. 1.

For steam raising three Steinmüller boilers are used, working at 180 lbs. pressure, and each having a heating area of 1,630 square feet. The boilers are fitted with Leach's patent mechanical stokers. These were supplied by the Sächsische Maschinenfabrik of Chemnitz, successors to Richard Hartmann; they are driven through a countershaft by means of a small polyphase motor, taking current from the lighting mains of the station. The interior of the boiler house is shown in fig. 1, whence it may be seen that the stop-valves in the steam pipes can be operated from the floor. The boiler house measures 42 feet by 38 feet. The shaft is 148 feet high, and has an inside diameter of 6½ feet at the top; this is sufficient for the whole plant.

The steam pipes from the boilers to the engines are duplicated throughout, and are laid in underground conduits. Not only these pipes, but also the engines, are provided with an abundance of drain-cocks.

In the engine house, which measures 74 feet by 32 feet, and is 23 feet high (fig. 2), there are three triple expansion condensing engines by the Sächsische Maschinenfabrik of Chemnitz. The engines have 15¾-inch stroke, and cylinders, respectively, 10½, 16½, and 26½ inches in diameter; at 150 revolutions per minute, and with 160 lbs. steam pressure, they develop, normally, 150 H.P. each, but are able to work up to 220 H.P. The valve gear is actuated directly by the governor. A new arrangement, patented by Siemens and Halske, has been used here, and in the central station at the Dresden terminus, by which the regulation of the steam admitted to the engines can be effected from the switchboard. For this purpose each engine is provided with a small electric motor, which is connected up in the main circuit of the exciters, and can be started running in one or the other direction by means of a two-way switch on the main switchboard, thus applying greater or less weight to the governor

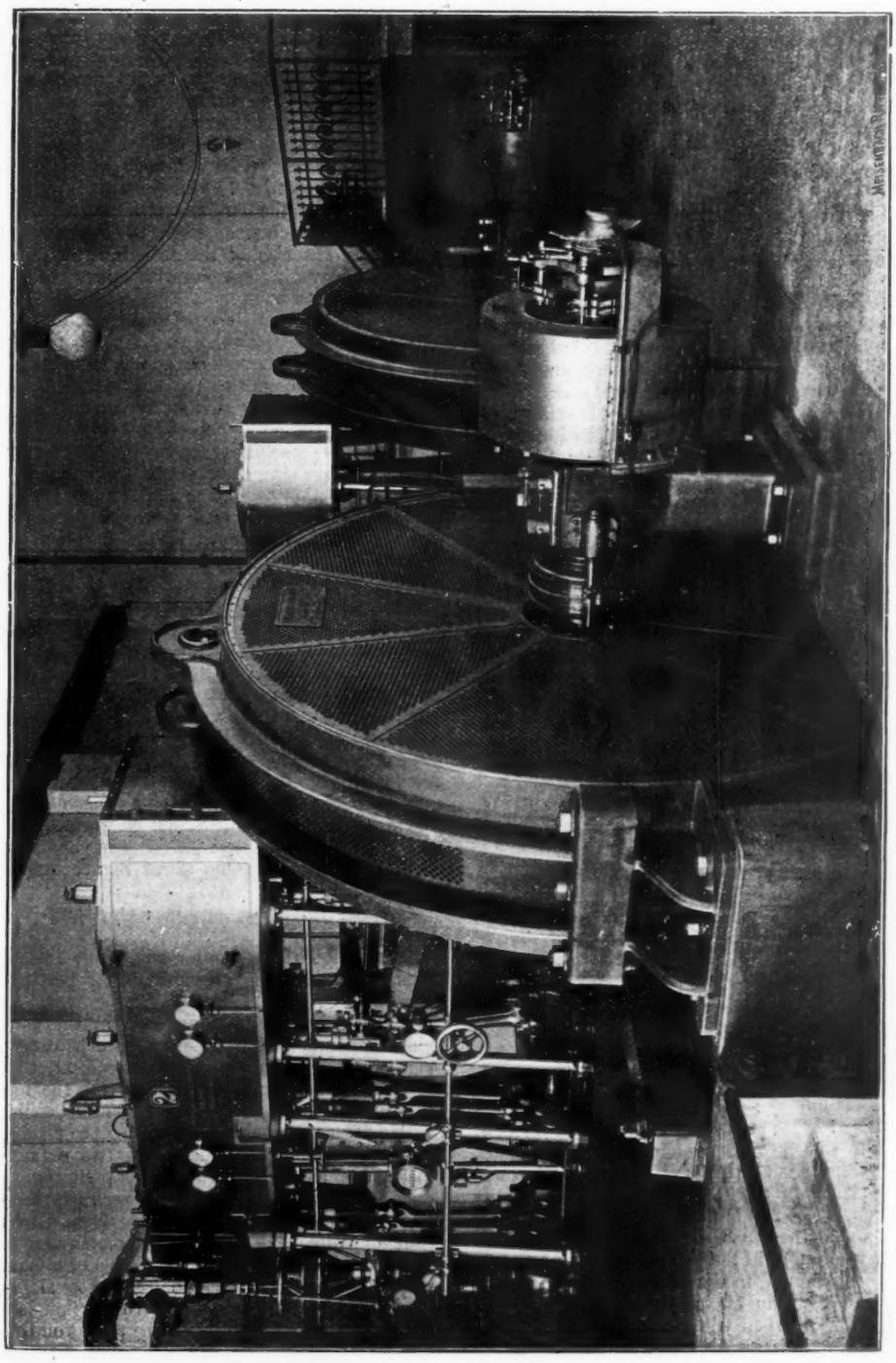


Fig. 2.

by means of double pawl and wheel gear. This apparatus is of very great service, especially when machines are thrown in or out of work, since the position of the governor weight may be arranged at will.

The shaft of the rotating field magnets of the polyphase dynamo is coupled directly to that of the engine. These dynamos are of Siemens & Halske's type R, and have an output of 52 ampères at 2,000 volts, or for $52 \times 2{,}000 \times \sqrt{3}$ watts, say 180 kilowatts. The armature of the exciter, type J, is also attached to the shaft of the polyphase dynamo; this exciter gives a current at 120 volts pressure.

The polyphase dynamos consist of a fixed outer ring, and an inner rotating star-shaped core. Both are constructed of insulated iron discs. The inner portion, mounted on a strong shaft, constitutes the magnets, which are energised by a continuous current from an independent exciter. It is provided with pole-pieces, the number of which varies with the size and speed of the machine; in the machines used at Chemnitz there are 40 pole-pieces, corresponding to the number of 150 revolutions per minute and a frequency of 50 ~. The energising coils are wound round the pole-pieces, and to them the exciting continuous current, which here has a P.D. of 120 volts, is led by means of two contact rings. Since the field magnets are built up of iron sheets, the loss from eddy-currents is very small. Also this construction renders it possible to build the machine of various breadths without material changes in its shape, and consequently to obtain various outputs for the same speed. The iron discs forming the outer ring are securely held by bolts in a cast-iron framing. The outer ring has on its inner surface a series of slots, generally three for each pole-piece; in these slots is embedded the winding consisting of three portions. The slots are wide, and thus allow of the winding being very solidly insulated from the iron core. This insulation consists everywhere of mica, which for protection is enclosed between pieces of press-spahn.

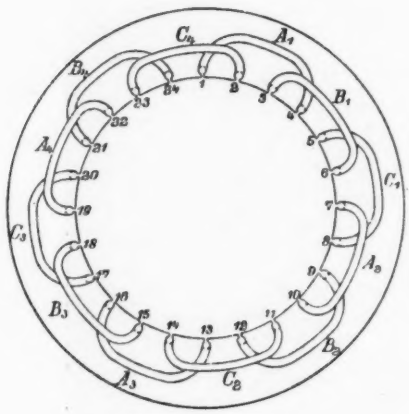


Fig. 3.

The winding may be followed from the diagram (fig. 3), and is carried out as follows:—A wire coming forward from behind through slot 1 is led at the front surface to the slot 4, at the rear back to slot 4, so that a closed loop is formed. This method of winding is continued as many times as there are wires to be placed in the slots. Then a wire coming from behind through slot 2 is brought over to slot 23, along which it passes, and at the rear back to slot 2. This winding is continued as often as in the case of slots 1 and 4. In the same way a coil is wound in slots 3 and 6, 5 and 8, 7 and 10, and so on. In fig. 3 an eight-pole armature is shown. The coils A_1, A_2, A_3, A_4, are here connected up in series, since a current of high tension is wanted; as are the coils B_1, B_2, B_3, B_4; and the coils C_1, C_2, C_3, C_4; the ends of the three portions are joined up in a neutral point, the three beginnings are led to the three terminals of the machine. The connection is thus that known as star-connection. The connection can of course be made in other ways; thus the end of A may be joined to the beginning of B, the end of B to the beginning of C, and the end of C with the beginning of A_1, and these three connections may be led to the terminals of the machine, which would constitute a triangular connection. The winding is so carried out that at the ends of the armature half of the coils, in fig. 3, coils A_1, C_1, B_2, A_3, C_3, B_4, lie closer to the iron core, the other six coils being wound over them. The jaws of the slots are somewhat narrower than the slots themselves, and after the coils have been wound into them, they are closed by wooden wedges, so that the coils are held quite tight.

The R type of dynamos are characterised by the fact that, with a non-inductive external resistance and continuous normal excitation, they show only a small variation in tension between no load and full load, viz., about 7 per cent. in all. For working motors, in consequence of the shifting of phase of current and pressure, the decrease in volts is much greater. With only motors on the circuit it may increase about fourfold. The efficiency is stated to be equal to that of continuous current dynamos, in larger machines it is about 92 per cent.; with continuous running the heating is slight; in the present case, with machines built for 180 kilowatts, but only used at most for 150 kilowatts, it is quite small.

The shape of the tension curve of the machines does not differ much from a sine curve; the humming when at work, in spite of the size of the machines, is very slight, so that even in the evening nothing can be heard at a little distance from the engine house.

The efficiencies of these polyphase machines vary, of course, with the purpose for which they are used; for working glow lamps only it will be highest, lowest for motors only; in this latter case, on account of the shifting of phase, it may decrease to about 70 per cent. of the maximum.

The arrangement of the exciters directly on the shafts of the polyphase machines necessitates, on the one hand, their being of large size, since the speed is comparatively slow, and, on the other hand, a proportionately greater dependence of the pressure of the main machines on the speed, because variations of the latter will always influence both machines equally.

Still, the direct coupling of the exciters with the main machines brings with it a considerable advantage. The use of separate engines for the exciters is obviated, which would otherwise be necessary if the speed of the exciter and main machine had to be different; there is also an economy in electrical energy, since the direct-coupled exciter can be regulated by a resistance in circuit with the shunt magnet coils, whilst, if the exciters were joined up to omnibus bars, resistances capable of carrying the whole exciting current would have to be used. The chief advantage, however, is the simplicity of the switching arrangements, and of those for throwing machines in or out of work.

For each machine unit the following apparatus suffice:—

For the exciter: One shunt regulating resistance; one ammeter.

For the polyphase machine: One three-pole switch; one ammeter; one wattmeter.

In addition there are for the whole installation: Three pilot voltmeters; one arrangement for putting machines in parallel.

As the polyphase machines used in this station are provided with auxiliary windings, which carry an eightieth part of the pressure of the main current, the small transformers which were formerly used for the measurement of pressure and for the running in parallel could be dispensed with. The arrangement for putting the machines in parallel has two commutators, each with two segmental strips of metal and a number of contacts; sliding springs placed opposite to each other connect respectively the opposite contacts with the metal segment next to them. Each two diametrically opposite contacts of each commutator are connected with the ends of the auxiliary winding of a machine; besides, there is a connection from the uppermost right-hand contact of the right-hand commutator to the left-hand voltmeter. If the right-hand commutator be placed on this contact, the left-hand voltmeter shows the pressure in the auxiliary winding of that machine, on the corresponding contacts of which the left-hand commutator is placed, the right-hand voltmeter, as well as the glow lamp in parallel with it are out of circuit. In order to put two machines into parallel, they have first to be separately brought up to the same voltage; for this purpose the two commutators are used as described above, the left hand one is first placed on the contacts of the one machine, then of the other. Then both commutators are respectively placed on the contacts corresponding to both machines;

the left-hand voltmeter is then cut out, the right-hand one and the glow lamp are in the circuit of the two auxiliary windings which are opposed to each other. The machines are in parallel, when it is shown by the needle of the voltmeter vibrating about zero, or by the extinction of the lamp, that similarity of phase exists in the auxiliary windings, and therefore also in the main current.

The putting of machines in and out of parallel can be carried out with ease in the shortest space of time. As evidence of the extreme simplicity of the whole plant, it may suffice to mention that the machines and switchboard are entirely looked after by the engine drivers.

(*To be continued.*)

ON THE BLACKENING OF INCANDESCENT LAMPS.

An article on this subject, of more than usual interest, occurs in a recent issue of *L'Elettricita* (Rome) by G. Tolomei. This observer has carefully examined filaments both before and after use by means of microscopes, the magnifying powers of which were 850 times enlarged. The film deposited on the glass was also similarly examined.

The appearance presented by an unused carbon is a regularly undulating surface. A used filament, however, has its surface covered with little humps resembling in miniature those on the carbons of electric arcs. These humps seem to have been produced by some melted material. Near the point of fracture, and often elsewhere, the filament seems to the naked eye to be covered with lamp-black. At such parts, and particularly near the break, the filament appears under the microscope to be furrowed by transverse cavities like craters, out of which rise ramifications of lamp-black which have the appearance of volcanic jets.

On examining the film of a blackened lamp bulb, the deposit is found to be much deeper opposite the point of breakage than in other parts. "This shows that the cause of the breaking is the same which produces the blackening of the glass, and is connected with the development of some gaseous substance from the carbon." The theory which has been held by some, that blackening results from the transference of carbon chemically by means of residual carbonic oxide, is thus proved to be incorrect. The hypothesis that a sublimation of carbon occurs, like that obtained by Moissan with the electric arc, is also untenable, for such a phenomenon could not give rise to the ramifications referred to. The microscopic examination of the film displays a very thin coating of lamp-black, in which it is easy to distinguish some larger grains irregularly distributed. "These grains are often assembled into strange shapes, and may be considered as thrown off from the filament, which have adhered to the glass. Among such fragments I have noticed the presence of some yellowish crystals of very different sizes. Owing to the exceptional transparency of such crystals, it was impossible for me to measure the angles of their faces. All the crystals may be easily detached from the glass, and appear quite like those of olivine. I do not attempt to prove their identity with this compound, but am certain that they are formed of a substance produced in the filament, and sublimated, owing to the high temperature."

From these observations the author concludes that the destruction of filaments is brought about somewhat in the following manner:—Certain mineral substances contained in the carbon become fused by the high temperature, and owing to the evaporation of these substances, the carbon undergoes a gradual disintegration, some very minute particles of carbon being projected on to the glass. When the explosions of the little humps present on the surface are at all violent, entire fragments are detached, and at those places where detachment occurs, most frequently the filament finally fractures. This explanation is not entirely satisfactory, for filaments which have been thickly built up from very fine cores with carbon deposited in the flashing process (the latter carbon containing, of course, no mineral matter whatever), disintegrate and blacken their bulbs just as readily as those with only a slight deposit of carbon. The degree of blackening of lamps and the lasting power of the carbons is, moreover, largely dependent on the manner in which the filaments are flashed—facts which are difficult to account for by Tolomei's theory. That the formation of the cellular channels brings about the destruction of the filament there can be little doubt; but that these owe their origin to the presence of mineral matter, does not seem to us to be conclusively proved.

Some of the microscopic observations above described have been before recorded, but we do not recall attention having been drawn to the existence of the transparent crystals which are here noticed. The article concludes with the following remarks:—"I have also undertaken a chemical examination of the filament and of the substance deposed on the bulbs; although this examination is by no means completed, it enables me to state that something other than carbon leaves the filament during the life of the lamps, and it constitutes the principal cause of its disintegration, and of the consequent blackening of the bulb. When my chemical examination is finished, I shall give the results in a later paper."

ELECTRICAL HEATING.

By H. J. DOWSING, M.I.E.E.

The *Gas World* of last week, criticising Mr. Crompton's paper on "Electrical Heating" at the Society of Arts, commented favourably on the cleanliness of the apparatus and the absence of fire and uncomfortable heat, but altogether disagreed with the writer of the paper on the economy of the gas stove, which Mr. Crompton put down at about 10 per cent. It goes on to say, "No self-respecting gas-stove maker would send out an oven so wasteful. Had Mr. Crompton reversed the statement, and said that gas ovens waste 10 per cent. of the heat energy of the fuel and utilise 90 per cent., he would have been nearer the truth." From this it would appear that the writer of the paragraph is unacquainted with the exhaustive tests carried out by Mr. D. Kinnear Clark on behalf of the Gas Institute in 1882. All kinds of stoves were tested, including the types in use at the present time, and in a most careful manner. As a result of these tests, Mr. Kinnear Clark sums up his report on gas ovens as follows:—"Barely one-sixth of the whole heat generated is utilised in roasting, and four-fifths of the total heat is dispersed wastefully. The average efficiency of the close gas cooking-stove is, say, 16 per cent." Bearing in mind the fact that these tests were carried out with the assistance of the makers' representatives themselves, and, according to Mr. Clark, were carefully "nursed," which they would not be in ordinary practice, we may conceive that the average efficiency of the gas stove—particularly when the burners are partly clogged—is not more than that named by Mr. Crompton. This, too, in spite of the fact that *the whole of the heat produced inside the oven is used for cooking*, although it is in the form of foul gases and partially burnt carbon, which is often found deposited on the sides of the oven.

The *Gas World*, in criticising Mr. Crompton's figures with regard to the heating of radiator plates, &c., compares the heat produced by electricity with that produced by gas, making no allowance for the fact that it would be impossible to use the whole of the heat produced by gas for warming rooms and public places. If gas is used for heating water, probably not more than one-fifth of the heat of combustion is actually utilised in the interior for heating the building. When this is the case, it is quite easy to see how electricity can compete with such a system. It must be borne in mind that open gas or coal fires are prohibited in theatres and public buildings licensed by the County Council. We are therefore reduced to one of two systems—hot air, or hot water. The former is not in favour with the British public, and those who have experienced the unpleasant effects of burnt air produced by the calorifères of Paris will well understand the reason. With the hot water systems—uneconomical and expensive to maintain—electricity appears to be able to compete, as the whole of the heat produced by the current is available for warming purposes. It is believed by many heating engineers that electricity will very shortly prove to be cheaper than all hot water systems. It entirely depends upon the action of the supply companies. For

church heating it would certainly appear to be a wise course for the companies to make an exceptional rate, for Sunday, when the heating is most required, is a day of little demand. Many churches are now considering the question of introducing electricity for heating purposes as well as for lighting, and if the cost of installing the new system is more (it is usually about the same), the saving of labour, and the ease of regulation, will more than compensate for the difference. In public buildings, where a separate plant is used, the cost of heating by electricity is very low, for current is often produced at a very small cost. The capacity of the lighting machinery can be slightly increased, and then, in one compact arrangement, you have the means of producing light, heat, motive power (for lifts, &c.), and ventilation. The saving in cutting about buildings for the purpose of adding hot water pipes, radiators, &c., and the space obtained, will of itself be a good return for any increased cost incurred by using the electric system. The durability of the latter should be considerably greater than of any hot water system, for there is practically no deterioration when the apparatus is out of use. This is not the case with ordinary hot water systems; in fact, rusting takes place chiefly during the summer, and when the heating arrangements are only partially so used.

Cases have already arisen where the owners of large buildings have it in contemplation to cut off their connection with the mains, and instal their own plant, in order to be able to produce current cheap enough for warming purposes also. One of the leading gas engine makers will guarantee the production of current at 1d. per unit, if Dowson gas is used, and at this price electric heating would be undoubtedly cheaper than the present systems employed. The innate advantages of the electric system will compel its use.

Supply companies cannot expect much increase in the demand for current during the day for lighting purposes, and motors are of slow growth; then why not, by a bold stroke, offer the current during hours of daylight, *if necessary*, at a little over works' cost, and so secure a large field at once. If consumers would only take up electricity for heating and cooking purposes at the present price, which, besides covering works' cost, includes a share of all other charges, it would, of course, be a grand thing for the companies; but this is not likely to be the case. Most companies are now paying increasing dividends on *lighting only*—a day load even at the low rates above referred to would add to this profit, and be the means of helping the lighting demand. This is invariably the case, for people who use gas for heating often hesitate, more than others, before dispensing with it for light. Some central station engineers have said: "We have circularised our customers and received many inquiries, but little result." Why? the inquiries have never been properly followed up. Conceive an insurance company having an inquiry from a likely insurer, simply sending him in reply a printed circular, with little or no information, or say, sending the "house porter" to interview him! The ordinary electrical engineer knows about as much of the heat required for cooking as the above individual about life insurance; but when the electrical man happens to get "netted" at last by an intelligent customer who has learned that there *is* such a thing as electric heating, he reminds one of the famous bull in a china shop—he makes a fearful mess of it. The simplest way to give a *seemingly* intelligent answer is to look with horror on the enquirer, and solemnly assure him "its far too expensive even to talk about!"

It seems to be the impression among many that in order to ascertain the heat units required to carry out any cooking operation, it is necessary to know how to prepare the food, or how to make a suet dumpling. One might as well say you cannot light a drawing room properly until you've learned how to make a "tallow dip." In lighting we leave the old methods to take care of themselves, and supply a pure light and plenty of it, and in the same manner we provide an improved means of heating which can be applied to the most necessary operations of daily life. The persons most concerned will soon say if the heat is right, and there the engineer's task ends. Economy in heating is as necessary as in lighting, and the more economy is practised, the more electric heating will be used.

Few persons who pride themselves on good cookery know what it really is until they have tried the electric system. Uncertainty is the order of the day with nearly every process but the electrical.

Undoubtedly the use of electricity for heating purposes is spreading, but it rests largely with the supply companies as to when this system shall become more general.

ELECTRICAL TREATMENT FOR THE SICK POOR.

The medical profession in New York is decidedly progressive, and in no direction is this more apparent than in electro-therapeutics. Not long since we had to chronicle a most successful meeting of the American Electro-therapeutic Association, and now, at least, one practical outcome of that meeting is an established fact.

In one of the poorest and most thickly populated districts of New York City there has been recently established a well-equipped electrical dispensary, presided over by a lady physician, whose name is well known and respected in electro-therapeutic circles on both sides of the Atlantic. Dr. Margaret Cleaves, having resigned the office of Secretary to the American Electro-Therapeutic Association, which she had filled with much energy and success during the past two or three years, has determined to devote her energies to the founding and management of the institution known as "The New York Electro-Therapeutic Clinic, Laboratory, and Dispensary."

East Twenty-fifth Street, between First and Second Avenues, is a location which has manifestly seen better days, and a glance at the houses and stores shows that there is no lack of poor people there. The modest announcement of the name of the dispensary affixed to the wall of No. 327 gives little indication of the wealth of appliances and skill to be found within, but once inside, the visitor is soon convinced of the thoroughness of the equipment.

The rooms at present fitted are all on the ground floor, but we understand that the whole of the premises can be brought into use as the work expands. No attempt at show has been made, but the rooms have been adapted to their present purposes in the simplest manner compatible with utility and neatness.

Dr. Cleaves received us in a small but cheerful reception room, on the tables of which we noticed electrical and medical journals, and readily agreed to show us over the institution. The "Gynecological Room" was first visited, and found fitted with a switchboard or table containing a Kennelly adapter with numerous accessories. The current used in this room is drawn from the Thomson-Houston supply mains (A.C. at 104 volts), and is made direct, when required for "constant current" purposes, by means of a suitable motor dynamo. We noted that the Hall-Brown perforated flexible electrodes were used with Amadon pads, and that these latter were kept suitably warmed in a neat little electric heater.

Passing on, we came to the "Eye and Ear Room," where a complete installation of galvano-cautery apparatus is placed, the current being taken from accumulators. Here is also a closet battery of 50 cells for general "constant current" treatment, with a large number of electrodes suited to the different forms of application.

The next room is devoted to general percutaneous applications, and contains a "sinusoidal current" apparatus of the latest type. Leads from the other generators are brought to a switchboard, so that any form of current necessary for any particular case is ready to hand, not the least useful of these being the static induced, controlled by one of Dr. Cleaves's water-rheostats. A special feature in this room is a cabinet bath where steam or medicated vapour is used in connection with electricity, various connections and electrodes being conveniently placed within the cabinet for this purpose.

In the "static room" we found a magnificent six-plate Morton-Wimshurst influence machine. It is driven by an A. C. motor supplied with current from the street mains, and is fitted with all the latest devices for varying the nature of the discharges. Numerous electrodes of the most approved patterns were close at hand.

Another small room contains apparatus for one of the newest forms of electrical treatment, viz., the "arc light bath." Two powerful arc lamps are suspended over a couch

so that a patient lying thereon is literally bathed in electric light, the eyes being protected by green spectacles. This novel form of treatment is at present largely a matter of experiment, but Dr. Cleaves states that it has already proved of considerable value, and she has good reason to expect great things from its judicious use.

Before leaving, we were shown a number of charts containing particulars of some of the patients under treatment, and noted with satisfaction the careful records made. Pulse and temperature readings are taken before and after each application, and at frequent intervals analysis is made of urine, &c. Such being the careful character of the work carried out, there can be little doubt that the staff of (four ladies and two gentlemen) doctors who assist Dr. Cleaves have not much time on their hands.

Although the dispensary has only been open a few weeks, patients are already numerous, nor is this to be much wondered at, for with such splendid and complete apparatus and such high class skill, it offers opportunities gratuitously to the poor which, with perhaps one or two exceptions, are not available to their richer brethren paying high fees. In addition to the dispensary work, the clinic cannot fail to be of value to practitioners and medical students who desire instruction in electro-therapeutics. We wish it every success.

THE DEMAND FOR ELECTRICAL ENGINEERS.

By B.Sc.

A WRITER in an American contemporary draws a somewhat gloomy picture of the prospects of electrical engineering as a profession. He says :—"There are, at present, probably not more than half-a-dozen distinct companies in the country that would be able to furnish the entire electrical equipment for a plant for light or power of more than 500 H.P. capacity. In these large works the design and planning of both plants and machinery is under the immediate charge of two or three electricians, who have a thorough understanding of the requirements of their work, as well as the theories which govern it. The ideas which they furnish are carried out by the draughtsman in an almost purely automatic manner by the use of tables and the slide rule. In the shop the work is carried on from working drawings, and no special knowledge of electricity is required. When the machines are tested for efficiency, or other qualities, the work is done according to some scheme worked out by the chief electrician, and the results are worked out by means of formulæ selected by him to fit the case in hand. In the central station for power and light we find the same conditions. The aim of the supply companies has been to turn out machines of the utmost simplicity of design and construction, so that it only requires a fairly good mechanic to make what repairs are needed. The work of keeping the machinery running is a matter of such simplicity, that almost any mechanic is thought equal to the task after a few months' experience." According to this somewhat pessimistic writer, there are not more than perhaps 20 first class positions open to the electrical engineer in the United States. But the same wail has been, and is still heard from all professions ; the average earnings of a barrister has been estimated at less than £50 a year. The unsuccessful and struggling men in all professions naturally wish to restrict competition. Electrical engineering is a young profession, and ought to offer better prospects to the young man of ability than the older professions such as law and medicine. It is an established principle of political economy that large profits can be made only in a new business. The effect of free competition in course of time reduces the profits on capital in a long established business to a minimum.

The British electrical industry ought to have a possibility of great development before it. In the United States there are said to be over 2,400 central stations and 600 electric railways ; in this country there are not more than 120 central stations and very few electric railways.

For the young man of practical ability and sound technical education, there ought to be a better chance of success in electrical engineering than in older professions, such as law or medicine. Many young men are attracted to new professions by their novelty, who have not the perseverance or ability to succeed in any profession, and the failure of such men throws a discredit on the profession which it does not deserve. The demand for skilled electrical engineers will increase when capitalists begin to understand that true economy does not lie in the employment of a cheap and incompetent man, who may waste the salary of a good man by inefficient management.

THE ROYAL SOCIETY CONVERSAZIONE.

THE first of the two annual conversaziones of the Royal Society was held on the evening of May 1st, at Burlington House. There were a considerable number of electrical exhibits, but only a few of these were novelties of first class importance.

Prof. Ewing's magnetic tester for measuring hysteresis in iron, which we describe this week in another place, is likely to prove one of the most valuable instruments recently placed at the disposal of the electrical engineer. It looks a handy little instrument, the specimens to be tested are easily fixed in the apparatus, and it is not too delicate for workshop use. Prof. Ewing's demonstrations of the method of using his tester were one of the principal attractions during the evening. Another novelty of great interest was Prof. Roberts-Austen's electrical furnace. The furnace consisted of a fireclay case lined with magnesia, and contained a magnesia crucible. The carbon electrodes were horizontal, and so placed that the arc in ordinary circumstances would be formed just over the crucible. In order to direct the arc on to the material to be heated in the crucible, the ingenious device is resorted to of producing a magnetic field with horizontal lines of force running transversely through the electric arc. This, of course, has the effect of deflecting the arc downwards on to the material in the crucible. For the purpose of exhibition, an image of the arc was thrown by means of a lens and a mirror on to a screen. The current used was about 60 or 70 ampères at 100 volts. In the same room Dr. Hopkinson exhibited his magnet with embedded coils, by which he has recently shown the retarding effect of currents generated in the iron, on the spread of magnetism through the mass of the iron.

Two somewhat similar instruments for delineating the form of the waves of alternating currents were exhibited side by side, by Prof. Hicks, of the Firth College, Sheffield, and Prof. Fleming. Prof. Hicks's instrument was designed to analyse the primary and secondary volts and ampères simultaneously. It consisted of a small synchronising motor actuated by the alternating supply, and making one revolution per eight alternations of the current. The motor carried a system of conductors arranged on the rim of a revolving disc, which passed under a system of spring brushes attached to another coaxial disc at rest. The springs were arranged in four sets, and each set was so arranged as to charge in succession a condenser to the potential due to the instantaneous phase. The condenser is then discharged through a mirror galvanometer, whose deflection will be proportional to the quantity to be measured. Any required phase could be read by turning the system of brushes bodily through the proper angle. In Prof. Fleming's instrument a synchronising motor is also used. This enables the instrument to be applied at any part of the circuit. The instantaneous potential at any phase is measured by a ballistic galvanometer. Both these instruments perform for the alternating dynamo the same functions as the indicator does for the steam engine ; in simplicity of construction, however, they compare very unfavourably with their prototype. Prof. Fleming also exhibited a form of resistance of small self-induction and very large radiative power. It consisted of very fine platinoid wire, wound longitudinally over porcelain insulators, which were kept apart by a spiral spring to take up the slack when the wire expanded by the rise of temperature.

Prof. Ayrton exhibited his student's simple apparatus for determining the mechanical equivalent of heat, which has lately given rise to so much discussion. 2,000 c.c. of water are warmed for two minutes with a current of about 30

ampères at a pressure of about 10 volts. The conductor by which the water was heated consisted of 10 feet of manganin rolled into a thin strip and formed into a double grid, so as to be used as an efficient water stirrer. The determination of the mechanical equivalent of heat on which Joule occupied so many years of his life is effected by this apparatus within 1 per cent. in two minutes—truly lightning progress. Mr. W. N. Shaw gave an interesting demonstration to illustrate the formation of cloud, by rarefaction of air and by the contact of hot and cold currents of air in glass globes. It is a pity that no attempt was made to illustrate the part played by electrical forces in the formation and dissipation of cloud, since these play so important a part in nature. Mr. L. Pyke exhibited an electrolytic cell arranged to give increased efficiency in the reduction of highly electro-positive metals from aqueous solution. As usually arranged, a mercury cathode is placed at the bottom of the cell, and the reduced alkaline metals amalgamate with the surface of the mercury. As the amalgam thus formed is lighter than the mercury it floats on the surface, and, as it becomes gradually richer in potassium, sodium, &c., it decomposes the aqueous electrolyte in contact with it, and forms a layer of hydrogen which resists the passage of the current. Mr. Pyke gets over this difficulty by placing his mercury cathode in a porous cell. The amalgam, in its richest condition, thus rises to the surface of the mercury to a point removed as far as possible from contact with the aqueous electrolyte. It has been found that with this cell the hydrogen is not liberated to anything like the same extent as in the ordinary cell.

Major Holden exhibited a set of optical electric meters which are made very small, so that they can be used like slides in a magic lantern. The scale and index are thrown in a greatly enlarged form on a screen, so that readings can be easily made with great accuracy. The small size of the working parts enable the instruments to be made dead beat, and to be used with a small consumption of energy. The idea has many advantages, but the addition of the magic lantern to the paraphernalia of the electrician must, in many circumstances, be inconvenient. Prof. George Forbes exhibited his torsion model of a submarine cable, in which E.M.F. was represented by torsion applied by a windmill, the sending condenser by a spring, and the receiving condenser by a magnet controlling a mirror. The signals of the model were shown side by side with those from a 2,000-mile cable lent by Dr. Muirhead, so that the synchronism of the two spots of light could be readily seen. This model may be useful for teaching purposes, but it appears to us to be quite as hard to understand as the electrical phenomena it is intended to illustrate. Specimens of the incrustation on the insulators of the electric light mains at St. Pancras were shown by Major Cardew. The deposit was said to be caused by the passage of alkaline salts, in solution to the negative main, the salts having been chiefly derived from the neighbouring soil through the action of the fibres of the wood bearers. The quantity of the deposit shown would, in that case, give the impression that the wooden bearers must have been soaking in brine.

A living specimen of the *malapterurus electricus* from the river Senegal was exhibited by permission of the Museum sub-committee of the Liverpool Corporation. This is the third or fourth specimen brought to this country. A photograph of an inscription on the tomb of Thy, the keeper of the pyramid of Nefer-ar-ka-ra, about 3,680 B.C., shows a drawing of this fish in one corner, which seems to show that the Egyptians at this early date were acquainted with the electric shock. Mr. Crompton showed in the library the latest form of his potentiometer for ratio measurement, which is capable of making measurements accurate to 1 in 1,000,000. He also showed some simple forms of platinum thermometers for use with the potentiometer. The experimental apparatus showed how small a quantity of electric energy was required to maintain a small crucible at a constant high temperature when it is heated by the partial incandescence of a wire which surrounds it, and radiation is prevented. Annealing furnaces can be very conveniently heated on this system, and the fall of temperature regulated to a nicety. Downstairs Mr. Crompton exhibited his electrical heating apparatus for heating tools and appliances used in trade, and also for domestic purposes.

The preparation and combustion of acetylene from calcic carbide produced in the electric furnace was shown by Prof. V. B. Lewes. The flame produced is undoubtedly of startling brilliancy. It is stated that a consumption of 5 cubic feet per hour of this gas gives 240 candles, which is about 20 times as much light as would be given by the same consumption of ordinary illuminating gas. For many purposes where expense is of no importance this new illuminant may be valuable, but as a substitute for gas or electric lighting we fear it is an *ignis fatuus*. The cost of the calcic carbide has been recently stated to be about £4 per ton, but an American correspondent informs us that an application to a firm in New York elicited the fact that the present selling price is £56 per ton.

Lord Armstrong showed during the evening lantern slides of photographs and dust figures of the electric discharge, which showed some hitherto unobserved phases of the brush discharge accompanying the electric spark. Sir Benjamin W. Richardson exhibited an electrical cabinet for use in the wards of a hospital. This cabinet combines in a convenient form all the electrical appliances ordinarily employed for medical purposes in a hospital. It can be moved from bed to bed, and supplies a continuous or intermittent current, a light with a reflector for illuminating the throat, and an electric cautery. It is also fitted with a Hughes electric balance for testing the hearing.

There were a large number of exhibits relating to other branches of science, some illustrating the latest progress, and some of which it would not be difficult to find a score of anticipations in the records of the past. These we have not space to describe.

WAVES AND VIBRATIONS.

VI.

In the concluding lecture of the series, Lord Rayleigh showed that sensitive flames were responsive to vibrations of high frequency. A sensitive jet could, however, be obtained by allowing a solution of potassium permanganate (ordinary Condy's fluid) to pass through a nozzle into a vessel containing acidulated ferrous sulphate. By this means the effects are rendered more manageable than with jets in air, and we obtain a response to vibrations having 10 to 20 periods per second, compared with which sensitive flames are most sensitive to periods more like 2,000 per second. With high pressures on the gas producing the flames, the pitch to which the greatest response is obtained becomes higher still.

If it be asked, what is the difference between a jet of liquid in a liquid and of air in air? the answer must take into account inertia and viscosity. Viscosity governs the phenomena in the main as it tends to control the motion itself and to determine the kind of motion which takes place. Water is, curiously enough, less viscous than air; but we are not limited to water only, and we may vary the liquid. Thus a mixture of one-half alcohol and one-half water is much more viscous than either of these fluids taken separately. With a jet playing into such a mixture the pressure requires to be raised enormously to get the same sensitiveness, the head reaching something like 1 or 2 feet, whereas, with water only ·2 or 3 inches is quite sufficient. The viscosity is reduced at high temperatures; on this account considerable pressures can no longer be supported by hot water and a jet playing into an atmosphere of hot water prematurely flares.

Instantaneous illumination can be used to ascertain the manner in which the disintegration of the jet occurs. Photographs were shown of jets impregnated with bichromate of potassium and suddenly illuminated by the electric spark. From these it was made evident that the jet on its progress tends to become retarded, and that it does not break up into drops but by becoming sinuous. The coils so formed get as it were in each others way. Finite slipping takes place at the point where they meet, as the equilibrium is of an unstable character and the separation does not long remain plane. In virtue of fluid viscosity there would be a communication from one to the other. In the absence of viscosity the greater effect would be produced by outside disturbances of suitable frequency, the less the wave length of the sinuosities. For the case where viscosity is present, the smallness of the wave length

is not affected. Jets are not equally sensitive to disturbances reaching them in different directions on account of this peculiarity. Thus, a given jet might be extremely sensitive to disturbances coming from the north or south along a horizontal line, but at the same time it would appear to be insensitive to similar excitement from the east or west. The plane of greatest sensitiveness tends to lie in a particular direction owing to something not symmetrical in the jet itself. Lord Rayleigh succeeded in carrying his audience with him in the brief investigation which the time at disposal permitted of such effects. The experiments were very striking in character, and their apparent simplicity only added to the interest with which they appealed to those present.

Another example of a sensitive jet, which Lord Rayleigh described as a kind of telephonic magnifier, can be obtained by taking a couple of glass tubes mounted so that their axes fall upon a straight line through their centres; these are set with their adjacent ends a short distance apart and a supply of air under pressure (say from a foot bellows) is connected to one. The wind jet then issues so that it strikes the second tube end-on. To the further end of the second tube a ear tube is connected as a kind of receiver. If a bowed fork be held near the air jet when in operation, the musical note will apparently be greatly magnified as heard by a listener at the ear tube. The sound is greatest when there is a movement of air to and fro across the jet from which the air issues. The to and fro motion is caused by the sound waves from the fork impinging upon the jet, but this requires that the tuning fork be held unsymmetrically.

Lord Rayleigh went on to state that the explanation of these effects partake of the nature of hydro-dynamical problems, such as deal with the motion of viscous fluids. The true agent in a sensitive flame is the unignited jet. With high pressure flames, however, such as respond to notes two octaves above those affecting the human ear, the results depend to some extent upon the fact that the jet is ignited. Highly heated air has great viscosity. Liquids are less and gases are more viscous when they are heated. One point to be attended to is that the tube through which gas is admitted to a sensitive flame should be clear; any constriction causes premature flaring of the flame. In the tube, however, there is no disturbance of the character of sound or noise.

Passing from objective effects to the human ear itself, it was pointed out that the ear reaches a very high degree of sensitiveness. The earliest estimates of the kind were made by Boltzmann, and were afterwards explained by the work of Helmholtz on the organ pipe. Lord Rayleigh has himself made a number of experiments to determine the faintest audible sound by observing the greatest distance at which a whistle, giving about 2,730 vibrations per second and blown by water power, was audible without effort in the middle of a fine still winter's day. The calculations were based upon the amplitude and velocity of the aerial motion since the energy supplied to the whistle was assumed to all go into sound and none to be lost on the way to the ear. As a superior limit the maximum velocity of the vibrating particles of air at the limit of audibility was found to be ·0014 cm. per second. This was all there could be at the place; where the ear still hears the sound, the amplitude was $8{\cdot}1 \times 10^{-8}$ centimetres. The microscopic limit may be taken as the one hundred thousandth of an inch. So that this amplitude of motion is well within that limit. Reckoning the amount of condensation and rarefaction, s would equal $4{\cdot}1 \times 10^{-8}$ atmospheres, somewhere about one twenty-millionth, all these values being superior limits. Another method, described by Lord Rayleigh in this lecture, having the same object was based upon a knowledge of the energy in a vibrating tuning fork. The energy lost could be calculated by the dying down of the vibration when it was caused to act on a resonator, and the time was observed in which the amplitude fell, say, in the ratio of two to one. Then the following particulars would be known: the energy given to the fork, the energy given out per second, and the rate at which energy is being given out when the sound becomes inaudible. Sound could just be heard when the condensation reaches a value of $s = 6 \times 10^{-}$ as calculated from these experiments. The location of the source of sound is another matter. The sense of direction depends entirely upon the use of two ears, and even then we are at a loss to state definitely the direction when the source is right in front or right behind an observer. Lord Rayleigh described the proper method of conducting such experiments with two forks, two resonators, and a listener midway between. With this the course closed, and we can only repeat the remark made to us by a valued scientific friend, that it is difficult in print to give an idea of the interest attaching to these lectures, but it is to be hoped that what has been said in these columns has not altogether failed in that respect.

THE TELEPHONE SERVICE: PARLIAMENTARY INQUIRY.

The Select Committee sat again on Tuesday, April 30th, Mr. Arnold Morley again presiding.

Mr. Bebridge, Chairman of the Streets Committee of the Commissioners of Sewers, and also a merchant in the City, said that as the result of his experience, he considered the telephone system was very inefficient. When they wanted to communicate with a person they found the lines engaged, and they were rung up unnecessarily. It was the wish of the Commissioners to see a cheaper and more effective service, and a resolution had been passed that consequent on the use of the tubes laid by the City of London Electric Lighting Company being granted to a company, the price should not be more than £10. The Commissioners of Sewers did not contemplate having a system of their own, although he thought that they should have the right to conduct a service. He thought their veto as to the control of the streets should be maintained. In their own particular districts, he did not see why the Corporation and the County Council should not have the right to work systems. The tubes he referred to were laid surreptitiously by the City of London Electric Company, and they were now negotiating with them regarding them. The Commissioners had not circulated a scheme for getting the telephone for £8, but Mr. Foster wrote a letter respecting it at that sum. The Commissioners of Sewers were the road authority, and had control of the streets.

By Sir James Ferguson: He supposed the delay and engagement of the lines would be incidental to any system.

By Mr. Snape: Mr. Foster offered to supply the telephone for £8, but nothing was done. A mere formal letter was sent.

Do the Commissioners of Sewers think that a system could be supplied for £8?—I think there is no doubt about it.

By Mr. Benn: He had a good many friends, and their experience was the same as his. He was a subscriber to the New Telephone Company, and he was prepared to put up with the inconvenience of a rival system, because he thought they would soon have got the whole of the subscribers, for a man would not pay £20 for that which he could get for £13. He thought if the City and the County Council joined together in a system devised independent of the trunk wire systems, the people would put up with the inconvenience of having a rival business.

Mr. Ellis: Would you wish us to infer that the system is improving, or standing still?—It is standing still.

The Chairman: If a license were granted to the County Council, would the City Commissioners give them the control of their streets?—No, I think not.

Therefore to give a license to the County Council, as far as the City is concerned, would not do away with the wayleave?—No; I think the best way out of the difficulty is for the Post Office to take it over.

Mr. John Archibald Dow, coalmaster, of Glasgow, said he had 11 years' experience of the telephone, and always found the National Company's service good. The company's area was greater than the city's area, which was a great convenience, as they were enabled to communicate with their collieries. He would not like to see a licence granted to the city of Glasgow, because they might have to pay a double rental, and they would have a restricted municipal service. At present they could communicate with Paisley and other neighbouring towns, but it would be a great nuisance if they had to go over several services. He considered on the whole the service of the National Telephone Company was an efficient service. He came there as a private individual, but he could get a great many friends to corroborate his statements.

Mr. Snape: Would it not be possible for competition to exist, and intercommunication arranged between the municipality and the telephone company?—It is possible, but I would rather see it nationalised than municipalised.

Sir James Ferguson: You think delays would be incidental to any service?—Yes.

The Chairman: Has it been an improving service in your experience?—Yes; I have noticed a decided improvement.

Mr. Robert Kay, traffic superintendent of the Glasgow Tramway and Omnibus Company, said he had had experience of the working of the system for the last six years. They had 15 exchange wires and 17 stable connections. They had 200 miles of wire. He thought the work had been well performed by the present company, and he did not see why the corporation should take it in hand at all. It would not suit his company at all, as they could not get into communication with their district offices. They expressed general satisfaction with the service.

By Mr. Benn: He did not consider his company had been at loggerheads with the corporation, and he by no means wished to get his knife into the corporation. He was not there for the purpose of thwarting the corporation.

You have a powerful corporation accustomed to do its own work,

and who have control of the streets. If they organised a double wire system at considerably lower price without interfering with the National Company, why should that not be done?—If they worked side by side, we should have to go on both systems.

The CHAIRMAN: Do you think it would be detrimental to have the area restricted?—Yes.

Mr. JAMES WALDIE, partner of Messrs. Waldie & Son, colliery owners, said they had a number of collieries about Edinburgh, and they were all connected with the telephone. They had 14 private wires and eight on the exchange. They had been subscribers since the telephone started, about 18 years ago. They paid £142 a year. He used the system largely, and his experience of it was, that it was very satisfactory.

Mr. ALEXANDER RYAN said he was editor of the *Edinburgh Evening News*, and he considered the National Company supplied a very excellent service. All their quick work was done by telephone, such as elections, &c. They found the telegraph was too slow. Their experience was, that news reached them half-an-hour earlier by telephone than by telegraph. Their use of the telephone was by no means confined to the district of Edinburgh. He was at first inclined to be rather in favour of municipalising the telephones, but on further consideration of the difficulties he changed that view. He considered that it would be best in the hands of the State, but failing that the local areas, at all events, should be in the hands of one administration. He considered the service had been distinctly improved. It had been improved every year. The company had not changed the single wire system to a double wire system in Edinburgh, but he believed they were doing so in other parts.

The CHAIRMAN: Sir James Russell said that if the municipality took the system in hand they would exterminate the company. Supposing that was the result of granting a license to Edinburgh, would you view that result with satisfaction?—I think the granting of licenses for competition would be something of a national evil. It would mean waste of material and waste of capital.

Mr. BENN: Under the present circumstances, what do you think will bring a decrease in the rates?—Nationalisation.

By Mr. ELLIS: He thought the large majority of ratepayers would be adverse to taking over the telephone.

Mr. A. H. MONCUR, merchant and ex-Provost of Dundee, said he was acquainted with the trade and the commercial requirements of Dundee, and had been a subscriber to the National Telephone Company for 10 years. He considered the service was a very efficient one. He had read Sir John Laing's evidence, and did not agree with it. He did not think the telephone system should be municipalised. He was chairman of the local telephone company previous to its amalgamation, but they had a better service now, for previously the town was divided, half being on the local system and half on the National system. The result was they had to have instruments for each company, and then the service was not so efficient.

The CHAIRMAN: So although the competition cut down the price, the general effect of the competition was to increase the price?—Practically that was so. I am not favourable to competition, except in the way of bringing down the price.

What is your opinion with regard to the future system?—I am strongly of opinion that you should nationalise it if you do anything at all.

And in the event of the Government not seeing its way clear to do that?—I would rather then see it in the hands of a strong company.

Sir JAMES FERGUSON: Was the rate of £5 10s. remunerative to the old company?—I do not think we could have continued to pay a dividend at £5 10s. In making up our accounts, we allowed too little for depreciation.

Is it your view then, that such low rates could only be maintained by putting a certain amount on the rates?—I fear so.

Mr. JAMES CRUMBIE, merchant and shipowner, of Aberdeen, said the service in Aberdeen was very good indeed, but it could be a cheaper and more efficient service if greater facilities were given the company in the way of wayleaves. The company had had great difficulties with the corporation with regard to overhead work, and of course it was at the mercy of every person who refused to allow them to go across their house.

The CHAIRMAN: You have introduced the call wire system; has that been an improvement?—Yes, a vast improvement.

You are also able to send telegrams?—Yes; and that is one of the greatest possible facilities.

You hold a strong opinion against competing systems in the same area?—I think it would lead to absolute confusion.

Have you read Mr. Treasurer Bisset's evidence?—Yes, and I differ very much from it; I am astonished at it. I think it must have been given with complete ignorance of the telephone. I volunteered to come here as I would like, in my humble way, to defend the company against the unfair aspersions made against them.

Mr. Arnold Morley (Postmaster-General) presided over the resumed sitting of the Select Committee of the House of Commons on the telephone agreement on Friday last.

Mr. PROVAND, M.P. for the Blackfriars Division of Glasgow, was the first witness, and said that he came to speak on behalf of the business men of Glasgow.

The CHAIRMAN said the Committee had decided to confine Mr. Provand's evidence to the questions of trunk wire charges and trunk wire connections with local exchange areas in Scotland.

WITNESS protested against his evidence being confined to those two points; but in answer to the CHAIRMAN, said the trunk wire system was more fully developed and more complete in Scotland than in England. The National Telephone Company had issued a table which included 2,330 rates from one town to another. Those rates were charged at present, but under the agreement just entered into by the Post Office with the company, they would be very much increased.

The CHAIRMAN: There is no reference in the agreement to trunk wire charges?—There is reference in the Parliamentary paper, 267, p. 5. You will find the rates intended to be charged in the Treasury minute.

Yes; but they are not in the agreement?—We have heard it stated that the agreement carried out the Treasury minute. If the Post Office do not intend to charge those rates, you say so, and it will make it clear. The effect of the agreement will be to make the trunk wire charges enormously higher than now.

Will you point out any clause which bears out that statement. I think you may take it from me that there are no words in the agreement embodying these charges?—But you have written to a firm stating that there will be no variation in these charges.

Sir JULIAN GOLDSMID said he would understand then that the National Telephone Company had nothing to do with the charges.

The CHAIRMAN: No; that is the Post Office.

WITNESS, continuing, said he had got out a paper which he proposed to hand in, showing the Post Office mileage scale, the National Telephone Company's scale, and how both scales would work out. Up to 20 miles the company and the Postmaster would charge the same, but from 20 to 25 miles the Postmaster would charge twice as much; from 25 to 40 miles the charge again would be the same, but from 40 to 50 miles the Postmaster would charge twice as much as the company; from 50 to 75 miles the Postmaster would charge one-third more than the company, from 75 to 80 miles they charged the same, from 80 to 100 miles the Postmaster would charge 50 per cent. more than the company, from 100 to 120 miles both charged the same, from 120 to 125 miles the Postmaster would charge one-third more than the company, and from 125 miles to 150 miles again the charge was the same, from 150 to 160 miles the company for the first time would charge more than the Postmaster by one-fifth, 3s. against 2s. 6d.; from 160 to 175 miles the charges would be the same, and from 200 miles upwards the company would charge higher than the Postmaster. It must, however, be further borne in mind that the company did not always charge the rates they were entitled to. Of the 2,330 rates he alluded to, 349 of those were at 3d., 683 at 6d., 727 at 9d., 414 at 1s., 148 at 1s. 6d., nine at 2s. 6d., and three at 3s. According to the agreement, the charges for short distances would be much higher than now, and when the charge became very high for long distances, the Postmaster's rates would be a trifle—and only a trifle—less than those of the company. The company's rate up to 25 miles was 3d., but that of the Postmaster would be 6d. Out of the 2,330 rates, only 180 of them were over 1s., which was a proof that the bulk of the business done was for short distances. The Postmaster's offer of cheaper rates for long distances was one to which they could say, "thank you for nothing."

The CHAIRMAN: Is that not due to the fact that the trunk wire system is not extended as it will be by the Post Office?

WITNESS replied that he saw little chance for development of long distance traffic.

Sir JAMES FERGUSON: You will be surprised, then, to know that a member of the House of Commons telephones every night from the House to his partner in Manchester, and that there are many such cases?—I can only find one case of a merchant speaking over the trunk wire to Manchester, and he has to go to the company's office in London. I telegraph constantly to Manchester, but I should never think of doing business by telephone from London to Manchester.

Sir JAMES FERGUSON: This gentlemen does it every night?—Well, I tried to speak to Kensington and could not do it.

This gentleman from Manchester told me it was wonderfully clear?—Well, I could fill the room with witnesses of an opposite opinion.

Continuing his statement, WITNESS said he objected on behalf of the mercantile community against the Post Office charging a higher rate and making a gift of something to people who did not want it. If the Post Office did so it would be another of the gross injustices which it had practised on the community. Witness then proceeded to compare the rates between different Scotch towns with those proposed, and said the users of the telephone in Scotland would suffer severely.

The CHAIRMAN pointed out to the witness several cases where the Post Office charges would be lower for short distances, and this led to a warm complaint on the part of the witness that the Post Office had refused to give him the information he had applied for.

After consultation with Mr. Lamb (of the Post Office Department), the CHAIRMAN pointed out to Mr. Provand that the information he asked for would have entailed much heavy work on the department, and it was impossible for them to have accomplished it in the time at their disposal.

WITNESS further stated that he did not see why the Government should not enter into contracts with large users of the telephone to grant the use of the lines at a fixed annual charge. His justification for that would be that it was for the benefit of the public, and if the agreement was for the benefit of the public, then the Post Office had no right to enter into it. The same thing was done in respect of the Press with the telegraph.

The CHAIRMAN: Are you aware that there is a statutory obligation on the Postmaster to treat all alike, except with the Press, which was provided for when the telegraph was taken over?—Well, special agreements might be arranged when you take over the trunk wires.

Proceeding, WITNESS said that his own experience of the service in Glasgow was certainly that it was bad; but it never could be good as long as they had the single wire system. Mr. Forbes, the chairman of the National Telephone Company, said the same thing, and Mr. Wallace said that unless the large towns had double wires, a million of money would be wasted by the Government in buying the trunk wires. The cost of doubling the wires in Glasgow would have to come out of the pockets of the users; but under the agreement the company were not to be restrained in the way of charges. With respect to terminal charges, the effect would be that it would be almost impossible to have into town communication unless all muni-

cipalities established exchanges. He suggested that there should be no terminal charges.

Replying to Sir James Ferguson, Witness admitted that, from the Treasury minute, it was contemplated protecting the loss by the telegraphic service by the taking over of the trunk wires, and therefore that it was clearly contemplated that an adequate charge should be made; but he contended that the increased charge to the users was bad policy.

In answer to Sir Charles Cameron, Witness said that he was in favour of the municipalisation of the telephone.

Mr. Wm. Henry Preece, C.B., F.R.S., said he was engineer-in-chief and electrician to the General Post Office, and he brought over the first practical telephone to England in 1877, and had devoted great attention to the subject ever since. The first instrument in the telephone was the Bell receiver, and there had been little difference made in that up to the present time. It remained to that day the most delicate instrument they possessed. The transmitter was that part of the instrument which converted the waves in the air into electrical waves, and transmitted them to the other end. Every day they were receiving suggestions of improvements in this. The microphone transmitter was brought out in 1878, and was the one used still. Those instruments had to be connected together by wires forming a metallic circle. The one-wire system was a defective system, and led to interminable trouble.

The Chairman: I suppose the single wire was the first system?—No; we commenced with the metallic circle in the Post Office. It was the telephone company who used it for economy.

Witness said that the twin-wire system was being very rapidly introduced into England. It was now used very generally throughout the United States. The switchboard derived its name from the railway, and by means of it the operator transmitted the current from one wire to another. They took different forms, as the members of the committee saw on the occasion of their visit to Lime Street. A great advance was made in switchboards by the introduction of the multiple switch. It gave each operator complete command over every subscriber on the exchange. But while it had facilitated the work of the exchange, it brought various troubles in the multiplicity of jacks. A switchboard with 10,000 subscribers would mean three or four million joints to be made in one room.

Sir Charles Cameron: And the whole of these can be controlled by one operator?—Yes; it can be done.

The Chairman: Of course, 10,000 subscribers would be divided amongst a large number of operators?—Yes.

But the multiple board would enable each subscriber to communicate with the other?—Yes; there are 50 sections, and each section is complete in itself.

Continuing, Witness said in Chicago they were trying a divided board. Experiments were being carried on in America, and the Department was watching the results. He visited America in 1893, and he had been in correspondence with the telephone companies there since. When one subscriber wanted to come into communication with another, the first operation was that of calling. Each subscriber must attract the attention of the exchange operator, and the operator then called the person whom the communication was for. That was done by raising the indicator in the exchange, or, in the case of his house, by ringing the bell. They had considerably modified that method in the Post Office by introducing a system peculiar to the Post Office. It had attracted a good deal of attention in the United States, and they were now using it there. Instead of relying on ringing bells, they had introduced a system by which the indicator gave different signals. But there was another modification, known as the Law system. There was also the call wire system, when the operator had always the telephone to his ear at the central office, and the subscriber had merely to call through and say whom he wished to speak to. Opinions were very much at variance as to the different methods, but, of course, as an official, he considered that of the Post Office the best in the world. The Law system had not been received with favour in the United States. Personally, he liked the system they had in the Post Office, because it did two other things. It gave automatic and instantaneous notice to the operators that the wire was engaged or disengaged, and when the conversation was over. As soon as a subscriber wanted to communicate, he simply lifted the telephone off the hook, and that was the call signal. The operator asked at once, and received instructions, and said if the line was engaged. When a conversation was finished, they did not have to ring off, but the mere fact of putting the telephone on to the hook was an indication that the conversation was over. It had not met with much encouragement from others, as it involved the use of batteries, and that was thought to be expensive, although they at the Post Office found it so small that it did not appear in their accounts.

Sir Julian Goldsmid: Of course, if the operator can see that the wire is being used or is not being used, a great quantity of time is saved.

Witness said that was the object of its introduction. It informed the operator at once if the line was engaged, but in the American system and the system used principally by the telephone company in England, the operator touched the plate, and if the line was engaged it gave a clicking in the telephone which told him so. The wires were now copper, or sometimes bronze, but at first they were iron. There was some reaction in the iron which seemed to absorb a good deal of the energy which produced clear speech, and the result was that the voice became blurred, and they lost those intonations which distinguished one man's voice from another.

Sir Julian Goldsmid: Is there a great quantity of iron wire still left in England?—No; there is very little. I do not think the telephone company use it, and we do not put it up.

The Chairman: Now, in reference to the comparative merits of the overground and underground systems.

Witness said the conductors placed overhead when few in number were cheap, and where they were few in number and were placed underground, they were dear. There was an advantage of having trunk wires overhead, but there was no disadvantage in having local wires underground. The underground wire, like the cable, retarded the electric current, just like iron absorbed those minute electrical waves which gave the distinction between one man's voice and another. In fact, it choked speech. It was not unlike speaking through a long speaking tube. Where they had lines of any length underground it spoilt that articulation. That was due to the electrical quality, the capacity for retaining its charge of electricity. They could measure the capacity of any wire, and they could reduce it, but they could not remove it altogether. If all the wires of large towns were underground, and they spoke through a long distance embracing those towns, the effect would be to retard the current and blur speech; but if they took those places by themselves, the effect was not sufficiently large to produce that.

The Chairman: We may take it, generally speaking, for long distances, overground is distinctly superior?—Yes; in long distances it is absolutely essential to have them overhead.

The London to Paris telephone, which is one of the best long distance telephones, is wholly overground?—Yes, with the exception of the Channel cable, and the subscribers at each end.

Continuing, Witness said they were improving very rapidly that defect, or rather they were reducing it. A very great advance had been made in America in the introduction of paper. It had reduced the capacity one-fourth. Wires coated with paper were certainly giving good effects. The result had been they could use four times the length of line with the paper covering than with the gutta-percha cable, and there was also a very considerable reduction in cost. The price of underground work when covered with gutta-percha, was almost prohibitive, and the price of gutta-percha was going up. The introduction of paper made the difference in the cost of overground and underground work practically disappear. Of course it was still more costly. The price per circuit per mile of a double circuit of line in a 3-inch pipe was, for gutta-percha, £55 12s., and for paper £18 per mile. For overhead the cost would be £15 or £16 per mile. He took the 3-inch pipe full. If they took a single wire, of course overhead would be the cheaper. A 3-inch pipe carried about 84 wires. While it was impossible to have underground work where they had six or eight wires, when they came to 100 or 200 wires it would be cheaper to go underground. They had had 10 years' experience of paper. It was adopted 5 years' ago generally in the United States. They had had experience themselves of about 5 years. They had used it exclusively for the trunk wires, and he had absolute confidence in its durability. It was a curious fact that there was not a single instance in the United States, or in France, of a failure of the paper cables. The whole secret of the use of the paper was the art of keeping it dry. It was placed in lead pipes, and water did not get in. If water did get in, it would decay rapidly and break down the circuit; but they could find out at once where the break was. It was more durable than gutta-percha. If it was kept dry it would last for 1,000 years, as was shown by their libraries. His observations were applicable both to the single and the twin wire system.

Sir Julian Goldsmid: I would like to know your opinion of the single wire system?—I do not think you can have a satisfactory service unless you have a twin wire.

Mr. Preece proceeded to point out the trunk wire system on a map as far as it was carried out, and said that by Tuesday they hoped to complete the line from Leeds to London. Then they would have a line from Glasgow to London, which was known as the backbone of the whole system. The system was based on the idea that Leeds was the most central town in the country, and should be made the exchange for the trunk wire system, and all the trunk wires centred in Leeds. He believed the construction of the line was as perfect as it could be. The backbone was formed of copper wire weighing 800 lbs. to the mile; some of the other lines were 600 lbs., and some 400 lbs. Lines would also be constructed to Bristol and Southampton and Plymouth, and the Ipswich and Colchester line extended to Lowestoft and Yarmouth. They had really spoken from Belfast and Dublin from Hampstead. Between London and Belfast it was quite as plain as between the City and Westminster. They had also spoken from Plymouth, through Bristol, Birmingham, Leeds, and Glasgow to London, a distance of 1,700 miles, which was certainly a record that side of the Atlantic.

Sir Julian Goldsmid: It shows what can be done.

Witness said he had every confidence that there would be no difficulty whatever in every one of the principal towns of the country speaking perfectly easily to every other town. He did not agree with Mr. Provand's evidence, for he believed the traffic on the trunk wires would enormously increase. He visited the United States in 1893, and got together a vast mass of statistics, showing the growth of the telephone in that country between his previous visit in 1884 and 1893. In 1884 there were 115,000 miles of wire, and in 1893 440,000 miles, and on the 1st of that year they had increased to 577,000. There was only one company virtually in the United States. In 1884 there was not a mile of underground wire: in 1893 there was 91,000 miles, and at the beginning of that year 148,000 miles. The telephones in use were, in 1884, 325,000, and now there were 582,000. That wanted a little explanation, because in the States they called the receiver one instrument and the transmitter another, whereas in England it was called one instrument. Really, it meant there were 291,000 telephones in America. In 1884 there were 123,000 subscribers, and in 1893 232,000; now they must be about 280,000. Everything had grown in the same ratio, except exchanges. To give them an idea of the work, he might mention that on one stormy Saturday in Chicago 153,807 calls were made and answered; 307,000 persons being placed into communication with one another. There were 15 exchanges in Chicago. In some of the busy houses in

Chicago they had as many as six circuits—they used it so much that it was an absolute necessity. In Glasgow and Liverpool there were often two or three telephones side by side, and of course, in Chicago, the climatic changes had an influence on the instruments. On March 11th he visited Paris, and inspected the exchanges there, and got all the information he could, and he found that a very considerable growth of business had taken place. In 1889 the business of the telephone company was transferred to the State. In 1880 there were 300 subscribers in Paris, and in 1884, 3,700; in 1889 there were 6,265, and the subscription was 600 francs, or £20 a year. On being transferred to the State the business at once grew, and the subscription was reduced from 600 francs to 400 francs. In 1891 the subscribers numbered 9,663, and in 1894 there were 14,041 subscribers in Paris. At the same time in the provinces 11 company and 29 State exchanges grew up to 257 exchanges. There were 14,067 subscribers in the provinces, so that now the total number of subscribers to the State telephone in France was 28,108. In Paris there were enormous underground sewers, and the wires were carried along these, but the objections to underground wires applied equally to those in subways.

The CHAIRMAN: We have had some evidence of increased expense consequent on the larger number of subscribers. Can you give any information of the operations necessary for an exchange call?

WITNESS said that from the moment a subscriber called till he got into communication with another subscriber involved three distinct complete operations. The operator was called, tested, answered and received instructions. He then tested to see if the correspondent's wire was clear or not, and rang up. If the subscriber answered he joined the two correspondents, and the whole thing was done. The time it took to complete these operations depended almost entirely on the skill of the operator in the first instance, but a great deal more on the attention of the subscriber. Half the complaints about telephone working was really due to the subscriber, and not to the exchange operator. The operation he had described was a local call. Where they had two exchanges and they had to use a junction wire, the number of complete operations was six, and it meant more delay in getting through. In working the trunk wire there were 12 operations. In America the subscribers looked on the telephone as part and parcel of the system, and tried to help its proper working, but in England if anything went wrong they growled.

Sir JAMES FERGUSON: Can delays be avoided on any conceivable system in the busy parts of the day?—Quite impossible, and it is in consequence of that delay that busy houses have several circuits.

The CHAIRMAN: We have had a good deal of evidence suggesting competing systems; would that not mean an increased number of exchange connections?—Certainly.

And an increase of delay?—Yes.

WITNESS proceeded to give statistics of the working in Buffalo, Boston and New York, and said that where there were more subscribers the cost of working was much greater. The mechanical work would increase *pro rata* with the number of circuits. The cost of fitting up the exchange with a multiple switch increased with the number of subscribers. Supposing they had 2,000 subscribers, and the number was increased to 4,000, the cost of the switch and its accessories would not be twice as much, but four times as much. It was that growth which rendered those large multiple switches prohibitive. The cost of mechanical work increased far more than the increase from subscriptions. Engineering expenses would come to about £3 per subscriber, and then, of course, rents, wayleaves, head-quarter charges and other things had to be added; that was not taking the initial cost of putting up the circuit into account. His estimate for an underground system would be £55 per subscriber for London, and £45 for the provinces. He had got a letter from the Director-General in Sweden with regard to the Swedish system.

At this point the Committee adjourned till Tuesday, when Mr. Preece will continue his evidence.

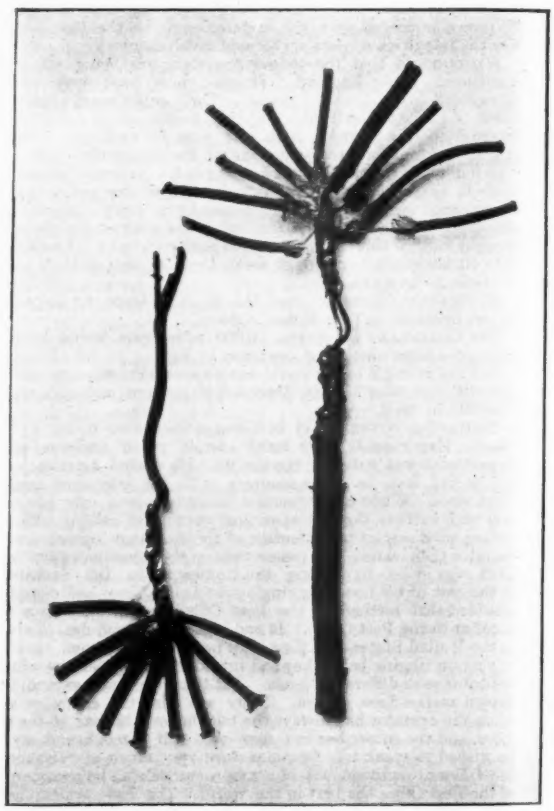
SOME EXAMPLES OF WIRING.

EVEN at the risk of reiteration, we feel it our duty to pillory a few more examples of bad wiring. Judging from the correspondence and the specimens submitted to us, it would appear that pernicious work is widespread, and permeates all classes of wiring. Nor must it be assumed that it is the poor devil of a wireman without capital, and anxious to do some work, who is alone guilty; the joint which we illustrate is one that has been designed by one of the most respectable firms in London; at least, a firm with which one has hitherto associated respectability. It is really incredible that a firm should have so little regard for its reputation, and that there should be in their employ wiremen so benighted as to perpetrate such hideous phantasies.

The pair of joints were discovered during some alterations to a house at a fashionable watering place. One of these probably exemplifies the lowest depths to which even a jerry wirer in his worst moments could sink. What we will euphemistically call the main branch is a No. 16 wire, to which is connected nine wires of No. 20 gauge; needless to say, such an arrangement was designed to carry current for nine lights.

We have very little desire to take up an alarmist attitude, but a contemplation of the possibilities that may arise fills us with dismay.

The second specimen we have received is a length of No. 20 cotton-covered bell wire, which was put in by an electrical firm of doubtful character. It is worth mentioning that the person who erected these has had some glimmering that the insulation of joints was desirable, and the glimmering takes the form of an inferior kind of cobbler's-wax. Another point of interest is that this No. 20 cotton-covered wire had three 16-C.P. incandescent lamps attached to it. We understand that this wiring formed part of an estimate for 20 16-C.P. lamps, one arc lamp, engine and dynamo, the full price of the estimate being £35. The firm which submitted, and partly carried out this estimate, were careful to explain that the work would be done in the American style, a statement which we are sure is unjust to our American friends.



Example No. 3 consists of three heavy joints cut from West End mansions. The wires are in each case simply twisted together, and are absolutely devoid of insulation. The casing which contained one of these terrible joints was charred black, and it was certainly not the fault of the wiring firm that there had been no fire.

The fourth example—and, in some respects, the worst—has been sent to us by a well-known central station engineer. It is interesting to give this gentleman's opinion as it stands, because it reveals the difficulties that a conscientious engineer has to face occasionally:—

"Two young men start as a wiring firm in —— on the strength of one of the two having served *three months* to a —— wiring firm. The firm do two or three jobs in an abominable style—rough casing, bad joints, cheap material—and then start wiring a private house from which these joints are taken.

"They draw in between ceiling floors No. 22 S.W.G. wires to feed three 16-C.P. lamps without casing or any protection. Their joints are in many instances void of solder absolutely. Rubber seems unknown to them as insulation.

"On my inspecting the work, they threaten legal proceedings because I cut out faulty work, and now are raising a hue and cry because I won't connect to their jobs!

I think that in the case in point the house was uninsured, the owner having only newly got possession."

NEW DEPARTURE (!) IN ELECTRIC LIGHTING.

On Monday last a party of some 50 gentlemen journeyed to Bristol as the guests of the proprietors of "Parfitt's patents for supplying electric light and power to small towns and villages." The object of the visit was to inspect the public lighting of the outlying village of Kingswood, and the public and private lighting of Keynsham, another village close to Bristol, by means of incandescent lamps in series.

The individuals composing the party consisted of one F.R.S. (Prof. S. P. Thompson), three representatives of the electrical press, and a larger group of newspaper men; the rest seemed to belong to the class vaguely defined as company promoters and directors, and the hosts of the day. Prof. Thompson was referred to as the expert from whom all technical information was to be derived, and a Mr. Casper was deputed to supply commercial data. From the professor we got absolutely nothing beyond what was already available from his report on the system, he pleading ignorance of all details of the installations on the ground that two years had elapsed since his previous visit; as for Mr. Casper, we deal with his points later on.

Incandescent lamps in series present no novelty. Years ago towns in America were lighted in this fashion by the Thomson-Houston Company, and for aught we know to the contrary, they are so running to this day. Heisler also did the same thing over many miles of wire.

Many other instances might be cited abroad, but we need only refer to one in this country, which was an example of real series lighting, which the Parfitt system is not, as we shall presently show. Series lighting pure and simple, we take it, consists in arranging a number of lamps in series on one circuit. As most of our readers will remember, the town of Barnet was lighted by Messrs. Joel & Co. for three years, from September 1st, 1888, to September 1st, 1891, on the series system, with 72 32-C.P. incandescence lamps, over five miles of street, and by means of overhead single wires and part underground cables. The lighting of Barnet was stated by Mr. W. H. Preece, after an inspection, to be a success. Mr. Preece said:—"He was pleased with the light generally, and thought it a good system for street lighting." The Barnet Local Board paid Messrs. Joel & Co. about £400 a year for their three years' contract time, and surely this speaks for itself as to the practical nature of the lighting. Messrs. Joel & Co. say that in no one single instance did the automatic device they used fail to act, and the whole of the lights were kept going, although during the three years some hundreds of lamps, one at a time, must have been replaced. The automatic device used by Messrs. Joel & Co. enabled fresh lamps to be inserted whilst the other lamps were running.

The Heisler system, to which we have previously alluded, was arranged to automatically put in a resistance when the lamp failed, apparently in a similar way to the Parfitt system.

The Bernstein system, also used for series incandescence lamp lighting, was automatically safeguarded by means of a by-pass of high resistance, made of oxide of mercury and powdered graphite, which, when all the current passed through, fused into a solid conductor.

Messrs. Joel used a separator of tissue paper, which when the lamp failed allowed the current to pass through with a metallic bridge, and this is stated to have never failed.

Now for the new departure, the Parfitt system of electric lighting by incandescent lamps *in series!* The extract which follows is taken from the only patent on which it is proposed to register a company.

Our invention relates to series electric lighting.

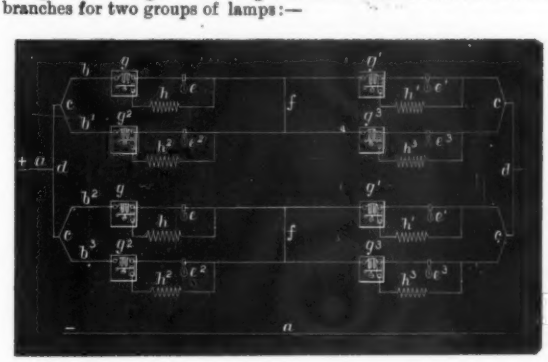
It is well known that when a number of electric lamps are arranged in series in a circuit, if one of these lamps fails, either all the lamps of the series are extinguished, or if an automatic cut-out is employed, the remaining lamps burn with increased brilliancy.

Now, the object of our invention is to provide means whereby in case one or more of the lamps in a circuit fail, it or they may be cut out, and a corresponding resistance or corresponding resistances automatically introduced without the other lamps in the circuit being overrun or otherwise affected.

In carrying out our invention, we form the main circuit with two, four, or other even number of branches, in which the lamps are arranged in groups and in series, and we metallically connect the two wires of each group between each pair of lamps.

In connection with each lamp we arrange an automatic switch, consisting essentially of a magnet and an armature. The coils of the magnet are so wound that the ordinary current will pass around them without attracting the armature; if, however, owing to the failure of one of the lamps an extra quantity of current flows through the coils, then the armature is attracted and switches in a resistance equal to that of the lamp which has failed. During the time that this is taking place the extra amount of current which flows through the branch containing the lamp which has not failed passes over the bridge, so that the other lamps are practically unaffected.

Fig. 1 is a diagram showing the main circuit divided into four branches for two groups of lamps:—



a indicates the main line circuit, and b, b^1, b^2, b^3 indicate four branches into which the same is divided, the two wires, b, b^1, of one pair, and the two wires, b^2, b^3, of the other pair being united at c, c, whilst the wires connecting the two pairs unite at d, d.

e, e^1, e^2, e^3 indicate the lamps of each group, and f, f, are the connecting pieces or bridges between the wires of each pair of branches. g, g^1, g^2, g^3 are the automatic switches arranged in connection with the lamps, e, e^1, e^2, e^3 respectively, and h, h^1, h^2, h^3 are the resistances which the switches, g, g^1, g^2, g^3, are respectively designed to throw into circuit in case of the failure of the corresponding lamp. It is to be understood that in practice the lamps may be of uniform resistance, or of varying resistance (provided they are arranged in pairs in the two branches of a pair), in order that the main current shall be sub-divided and flow equally through all the branches.

The operation of the apparatus is as follows—that is to say, if all the lamps are in perfect order the current will flow equally through all of them. Assume, however, that the lamp, e, on the branch, b, b^1 should fail, then an extra quantity of current would commence to flow through the lamp, e^2, on the branch, b^1, whereby the same would momentarily brighten: as soon, however, as this current reached the bridge, f, it would again divide and be equally distributed to both of the lamps, e^1, e^3. Immediately that the excess of current commences to flow through the lamp, e^3, the magnet of the automatic switch, g^3, is energised sufficiently to move its armature, whereby the resistance, h^3, is switched into the circuit, so that the current then flows partly through the lamp, e^3, and partly through the resistance, h^3. If, on the contrary, the lamp, e^3, were to fail, the excess of current passing through the lamp, e, would cause the introduction of the resistance, h.

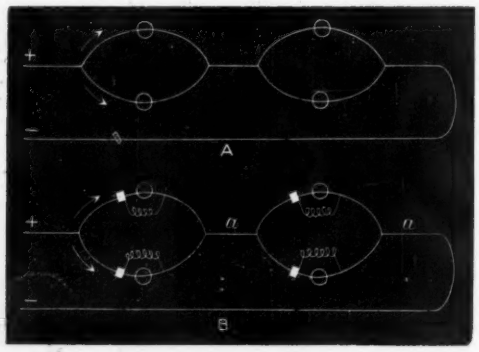
The resistance may be in the form of a lamp, so that in case one lamp fails another is substituted therefor.

It will be seen at the very commencement of the quotation that the Parfitts were labouring under a misapprehension, for in some systems we have already mentioned, the automatic cut-out, as it is termed, supplies a resistance equal to that of the extinct lamp; and, moreover, constant current dynamos regulate the E.M.F. to accommodate the number of lamps in circuit, the brilliancy remaining the same. Now, we will proceed to compare the Parfitt system with methods of connecting up which are common property. Everybody will admit that diagram A is the simplest example of what is known as the parallel-series method, and that it is a commonly used illustration. In diagram B we have simply added an automatic switch and resistance. Now it will be noticed that the two branch circuits unite at a between every set of two lamps; the cross connections, f, f, in the Parfitt diagram effect the same thing, so that in every respect our diagram is identical with that of Parfitt, only that, for simplicity, we have confined ourselves to two branches instead of four.

Parfitt's system, therefore, is not a pure series system at all, but a parallel-series, or, as it is termed by some, multiple-series method. This disposes, therefore, of the first claim in the

patent for dividing the main line into several branches; of the electro-magnetic switch we need say nothing.

Even Prof. Thompson, in his report, which, by the way, is likely in several instances to mislead the uninitiated, defines a series system as one in which "the copper wire that brings current to one lamp goes on from this to a second lamp and to a third, and so forth, so that the wire for 20 such lamps in series need be no thicker than that needed for



supplying one lamp." Furthermore he states that although the advantage of such a system is obvious, all attempts to apply it to incandescent lamps of moderate power have hitherto been practically failures. Either Prof. Thompson is unaware of what has previously been done, or his definition of a practical failure is at fault. If the Barnet lighting was a practical failure because at the end of three years the contract with Messrs. Joel was not renewed, the same thing might as fairly be said of the Parfitt lighting if the Kingswood authorities took it into their heads to give it up. Then, says the Professor, the system of Messrs. Parfitt being a *series* system, possesses the great advantage of economy in copper; "it has also the incidental advantage that the most distant lamp, if of equal size, will work just as brightly as that nearest to the station." Now, why did not Prof. Thompson add that copper economy and the brightness of the far lamp are advantages incidental to all series systems? Anyone reading this report would—indeed could—come to no other conclusion but that the Parfitt system alone was thus favoured. To our way of thinking a scientific report, unlike a legal document, should be couched in such terms that there can be no mistaking its meaning.

There are other points to which we might justly take exception, such as "the particular device which is the essence of the system, and which is covered by Messrs. Parfitt's patent, is that of splitting each circuit of lamps into cross-connected series," &c., but we will content ourselves by stating that generally speaking the report does not impress one with any great respect for the knowledge of electric lighting matters shown therein.

Mr. Casper's share in trying to exploit this scheme seems to have been confined to compiling a circular, in which he asserts that the reports of Prof. Silvanus Thompson, D.Sc., F.R.S., consulting electrical engineer to the City of London Electric Lighting Company, Limited, &c., show how completely the application of Parfitt's system, applied to small or sparsely occupied areas, realises the pretensions of its inventor. Also that a salient proof of its practical importance is given by the fact that the public lighting of Keynsham and Kingswood (two suburbs of Bristol) costs per unit less than 2¼d., whilst the average of other towns is between 4d. and 5d. The cost of coal per unit at Bristol is 1·27d., against 0·325d. by Parfitt's system at Keynsham, *vide* the Board of Trade returns. The low cost of installation fully verifies Prof. Thompson's appreciation thereof.

It also informs us that a company is about to be registered, having for its objects:—

1. To enable public authorities to acquire without any outlay and in perpetuity

(*a*) A complete installation for light and power, according to the present and future requirements of the locality.

(*b*) The power required and terms being arranged, the proposed company will erect, on land owned by the public authority dealt with, a complete installation for public lighting, and lay mains for private lighting and for the supply of power, delivering the works, plant, machinery, mains, &c., in perfect working order.

(*c*) The payment of the sum agreed upon would be accepted in 20 semi-annual instalments without interest.

(*d*) The whole installation would be maintained and all repairs and renewals would be effected by the proposed company, at its own cost, for an agreed monthly payment, so that the only charge on the public authority would be the collection of revenue shown to be due, by meters furnished by the proposed company.

Mr. Casper's comparison of coal consumption in a system run by a 12 H.P. nominal engine, working continuously at *full load*, and that in the central station at Bristol, is too ridiculous to require any comment.

A prospectus of the "Town and Village Electric Light and Power Company, Limited, Parfitt's Patent," came into our hands during the visit. Capital £200,000, divided into 199,900 ordinary shares of £1 each, and 100 founders' shares of £1 each, such founders' shares not ranking for dividend until 20 per cent. shall have been paid on the ordinary shares, after which they will be entitled to receive one-half the surplus profits. First issue of 131,566 ordinary shares and the 100 founders' shares, and 66,633 of the ordinary shares and the founders' shares, to be allotted to the vendors in part payment of the purchase money, and 2,500 to be retained (the dividends on which to be applied in part payment of the remuneration of the electrical engineer-in-chief).

The remaining 65,767 ordinary shares are now offered to the public at par, payable as follows:—5*s.* per share on application, 5*s.* per share on allotment, and the balance at a date to be fixed by the directors, with at least one month's notice of call. Quoting from the prospectus:—

"This company is formed for the purpose of acquiring the completed patent No. 17,324, of 1891, granted to Messrs. G. J. and G. J. T. J. Parfitt, for Great Britain, Ireland, and the Channel Islands, for "An improved method of electric lighting in series, and apparatus therefor," together with freehold land, plant erected thereon, stock-in-trade, and existing contracts of a syndicate now working the Parfitt electric light system at Keynsham, in Somersetshire, and Kingswood, in Gloucestershire, and the benefit of numerous negotiations with other towns for similar installations."

"No light can compare with the Parfitt for softness, colour, steadiness and brilliancy."

That Mr. Parfitt, by means of Edison-Swan, Sunbeam and Quanonne lamps, actuated by the current from a Crompton dynamo, can achieve results different from those obtained elsewhere shows more than anything the softness of those responsible for the compiling of this prospectus.

"For mines, the advantages of the Parfitt system are very important: (1) *The Parfitt is the only system known which will safely and efficiently light coal and metalliferous mines;* (2) No accident can arise by reason of any one or more of the lamps in a circuit being extinguished; (3) Whilst the Parfitt lamp is less liable to accident than any other, the extinction of *one or more lamps from any cause would not affect the others*, so that the mine would not be left in total darkness; (4) *This possibility, which has to this date deterred mine owners from adopting the electric light, will no longer exist.* The lighting of mines should therefore bring a substantial increase to the company's income. *On this head Prof. Thompson gives a very clear explanation.*"

To No. 1 we give an emphatic denial; there is nothing in No. 2 which does not apply to other systems; in No. 3 the extinction of one or more lamps in other systems would not leave a mine in total darkness; as to No. 4 we can only say that the company's technical advisers seem to have left the directors in the dark so far as mine lighting is concerned; and lastly, we can only find one reference of Prof. Thompson's which is to the effect that the same features which apply to Parfitt's system in village lighting also apply to mines.

We have necessarily been obliged to gather our facts, such as they are, from reports and the prospectus, simply because we were unable to obtain any reliable figures under any head from actual experience of the system. Perhaps the next quotation from the prospectus will explain our failure:—

"*The directors do not think it judicious to publish details of cost of installation or maintenance*, or of the basis on which the engineer calculates that the minimum dividend will be 20 per cent., but the *pro forma* estimates of Mr. Parfitt, based on work he has completed, will be shown to all applicants for shares."

And as a temptation to the would-be investor the very next paragraph reads:—

"*The directors suggest, for the consideration of investors, that the field of this company's operations is closed to other modes of furnishing electric light and power.* That its customers will consist principally of public bodies in Great Britain, that its earnings will be steady, permanent, and always increasing, so that its shares may be ranked among gold-edged securities of the highest class."

It is true that Mr. Harry Foster, M.P., who occupied the position of chairman during the proceedings, said that they only intended to ask the British public for £31,000; it is also true that the secretary of the projected company stated that the prospectus was got out last year, and that it was undergoing remodelling, but as the copy in our possession was sent to the office of one of the party only two or three days prior to the trip, we can but assume that, so far as he at least was concerned, the information therein contained was intended to correctly represent the situation.

To enter into details of the lighting of Kingswood and Keynsham would only weary our readers. Suffice it, then, to say, that the public lighting of the first-named village is carried out by 150 lamps of Edison-Swan, Sunbeam, and Quanonne types, and of three different candle-powers, 100, 35, and 25. At 11.30 p.m. the 100 C.P. lamps are shut down, and smaller ones in the same globe substituted. The engine is a Davey-Paxman 12 H.P. nominal, and the dynamos, a 130-volt 60-ampère machine, a second of 800 volts 12 ampères, and an exciter, are by Crompton; the secondary battery, which was rather a surprise, as no mention had been made of it, consisted of 380 K7 cells of the E.P.S. manufacture. These, so it was stated, are used in case of a breakdown of machinery. The circuits are 2½, 2, and 3 miles long respectively, and for the 800 volt circuits Glover's and Henley's insulated wires, supported on ordinary insulators, are employed; for the 130 volts bare wire is used supported in like manner. At Keynsham there are two Crompton dynamos of 65 volts and 200 and 130 ampères respectively, connected in series to form 130-volt circuits. The lamps, of varying candle-power, for the public service number 69, while the average number in use for private lighting is 125, although wiring has been carried out for 550 8-C.P. incandescents.

The engine here is like that at Kingswood, and the battery of accumulators is used for supplying the private lighting at an early hour, until it becomes necessary to fall back upon the dynamos for the demand. So far as we could gather, the private supply is run on the same lines as is usual with all companies.

The lighting in both places was excellent; indeed, we imagine the lamps were overrun, but that is not a point of any importance. There is no doubt about the practicability of the system, but we contend that multiple-series is open to everybody, and that the same result could be just as easily obtained by a pure series system, and at considerably less cost.

Nothing tangible was forthcoming as to whether Keynsham was worked at a profit or a loss, but the latter is the more probable. It was stated by Mr. Parfitt that he was paid £100 more for the lighting of Kingswood than it cost, but on what his estimate of expenditure was based we were not informed. That his percentage per annum of depreciation on the secondary batteries is much below the truth we are fully convinced, so there is no reason why the *estimated* profit of £100 should not appear by a different method of calculation to be little or nothing. Coal, we may add, is here obtained at the exceptionally low price of 8s. 6d. per ton, while gas is rated at 4s. 2d. per 1,000 cubic feet.

It will now be clear to our readers what the proprietors of Parfitt's system have to offer in return for public subscriptions, and even if the sum required is only £31,000, we need scarcely add that we fail to see how value is given for anything like that amount.

We must in conclusion say that everything which could conduce to the comfort and enjoyment of the visitors was most thoroughly carried out, both by our hosts and the staff of the excellent Grand Hotel, and we wish to express our appreciation of this, although we regret we cannot support the sanguine views of the proprietors of Parfitt's patent, any more than we can endorse the main features of Prof. Thompson's report.

CORRESPONDENCE.

"Lightning" and the St. Pancras Explosions.

I was gratified to find my last article on these explosions the subject of such kindly and intelligent criticism on the part of your brilliant little contemporary *Lightning*. I was even more pleased to discover that it considers me to be *steeped* in Tait. No more acceptable compliment could be paid to a humble student of a great master. I admit the soft impeachment, and the more gladly, inasmuch as it has been my constant endeavour these many years to absorb all that Prof. Tait has written, and to try and arrive at that mental attitude towards physical science which he so clearly defines and so earnestly inculcates. I have heard that Sidney Cooper, the famous and now venerable artist, has esteemed it something akin to flattery that his earlier work has sometimes been mistaken for that of his master, Wouvermann. This instance is a long way removed from the one in question, of course, but I can understand why Sidney Cooper was gratified. The *afflatus* of the master clings to the student, whether he will or no. A constant student of Tyndall, the exponent of lucidity in scientific theses, or of Thackeray, the apostle of elegance in literature, if he take pen in hand, can without helping it write in a style which recalls that of the master.

I am disappointed, however, that your contemporary did not carry its criticism a little further. Doubtless it would have found other opportunities for parallels. A man is no judge of what he writes himself, but it occurs to me that your contemporary might have found chapter and verse for that which inspired the sentence: "We have asked for bread and they have given us a stone." The inference would obviously have been, presuming the same principles of criticism were employed, that I was *steeped* in the New Testament; and, as a further inference, what a very good fellow must be

The Writer of the Article.

Gas v. Steam Engines.

After numerous articles published in sundry technical papers in France and England answering the comparison, gas *v.* steam engines, by Arthur Bollinckx, I now will resume the debate.

Under the practical point of view, variations of load, &c., it is my opinion that the steam engine still holds a fine place.

Only speaking of a sensible loss in the case of gas engines, it will be sufficient to name the loss of mechanical efficiency, and the friction of the gas engine absorbs much of the indicated power, and greatly affects the effective horse-power when the engine does not run with its full load.

Anent the consumption of which Mr. Aimé Witz speaks in his letter of April 12th in *Le Génie Civil*, the advantage rests with the steam engine, for Mr. Delamere Boutteville (see *Génie Civil* of April 6th, 1895) makes use of coal at 20 francs per ton, whilst I am using coal at 13·90 francs per ton, delivered at Brussels.

Taking Mr. Aimé Witz's calculations, we find:

600 grammes of coal at	20	francs,	0.0120	francs for	gas engine.
714 " "	13·90	"	0·0099	"	steam "

that is to say, 20 per cent in favour of steam, not taking the natural advantages of steam engine into account.

It should not be lost sight of that we based our calculations on an evaporation of 8 lbs. of steam per 1 lb. of coal, and we beg to say that in a convenient boiler plant this evaporation is generally surpassed.

I thank you very much for having allowed this very interesting question to be discussed in your valuable paper.

H. Bollinckx.

Electric Tanning.

Will you be good enough to bring under my notice a standard work treating principally of "Electrical Leather Tanning Operations," as also the names of good home firms supplying plants for this process.

P. T.

[There is no book on the subject. Messrs. Trotter and Rideal read a paper on "Electrical Tanning," which is to be found in *Journal* Society Chemical Industry, May 30th, 1891. One of the best systems of electrical tanning is that of L. A. Groth, whose address is Neckarstrasse, 88, Stuttgart.—EDS. ELEC. REV.]

"An Interesting Question."

In reference to the inquiry under this heading in your last issue, I would suggest that the destruction of the caoutchouc tube is due to the generation of ozone from atmospheric oxygen by the effect of the 2,000-volt alternating current.

I made the same suggestion in a somewhat similar case that was brought to my notice by the chairman of W. T. Henley's Telegraph Works Company, but I have not heard whether any steps have been taken to verify or disprove it. The effect of ozone on the neutral bichloride of gold, or on iodised starch, would afford an easy means of so doing. Perhaps a remedy might be afterwards suggested.

Desmond G. FitzGerald.

Books on Electrolysis.

I should esteem it a great favour if you would give me the benefit of your advice in selecting a book, or books, on electrolysis, both elementary and advanced; also, if possible, commercial applications up to date. Thanking you in anticipation,

Student.

[Of all text-books, you will find that J. T. Sprague's "Electricity: its Theory, Sources, and Applications," gives the best introduction to *electrolysis* and *electro-chemistry*. This introduction is mainly embodied in chapters ix. and x. Dr. Geo. Gore, F.R.S., is a widely-recognised and safe authority; his principal works are on "Electro-Metallurgy," and "The Art of Electrolytic Separation of Metals." The works of Alexander Watts have been very useful in the past, and can hardly be dispensed with in the present. In the French language, H. Fontaine's "*Electrolyse*" still holds its ground, and we have the large work of Donato Tommasi, the "Traité Théorique et Pratique d'Electrochimie," besides his smaller work on electroplating, &c. We have also the "Electricité Industrielle" of Cadiat and Dubost. But, in the case of the student of electrolysis, a good collection of books must be supplemented by careful and copious notes of the theoretical data and practical results from time to time published by the technical Press.—Eds. Elec. Rev.]

British Thomson-Houston v. Raworth.

On Saturday last the plaintiffs obtained leave to discontinue their action against me on the usual terms of paying the defendant's costs.

So ends a suit for which there never was the smallest justification, and from which no benefit has accrued to the plaintiffs beyond the adjournment of an interesting technical discussion for the space of half a year.

Your readers will remember that in your issue of November 2nd, 1894, there appeared a letter from Mr. A. C. Armstrong, of the General Electric Company, U.S.A., making an unsupported claim on behalf of his people to an amount of skill in the designing of alternators which has never been put forward by the less boastful electricians of this country.

The following week I exposed the fallacies of that letter, and pointed out that in building two dynamos to an English specification they had failed to comply with the requirements.

The clause was so carefully worded that no one could say for certain, and very few could guess, what dynamos were referred to; nevertheless, the following week a letter appeared in your columns from Mr. Henry F. Kite, solicitor to the British Thomson-Houston, accusing me of a "serious libel" on his clients, and stating that the whole paragraph was *absolutely false*.

This was very funny; it reminded one of the clergyman who, in denouncing the sins of his congregation, said: "I once knew a man, now in hell, who starved his wife to get drink, and was hanged for murdering his mother-in-law," when from the back of the church came a voice: "I'll have the law on you, sir; I'm not in hell, I'm still a bachelor."

People with bad consciences are very sensitive; if you say it was a black dog that stole the mutton, they immediately think it was their white dog that robbed the butcher.

To return to Mr. Kite, I, having the ace, King and Queen of trumps up my sleeve, immediately owned up, and dared him to send me a writ, which he did.

I have now spent nearly six months in trying to bring my accuser up to the scratch, but he will have none of it; he still believes in the good old adage, "He who fights and runs away may live to fight another day."

Half the interest of this electrical business is due to the press, every development in theory and practice is reported and discussed. Manufacturers with large interests at stake find their machinery and methods freely criticised, but they take the criticism in good part, and I cannot recall any instance of an English electrical firm having run off to set the law in motion against a contributor or against "the paper."

The position of our technical press is a position of which we are all justly proud; every inventor and manufacturer covets their good word, because it is free and fearless. When any journal expresses an opinion, some may think that opinion wrong, but no one suggests that it has been influenced either by money or by fear.

In the case before us, the firm has a name of which one-third is British, but its methods appear to be wholly alien. It is to be hoped therefore that if they continue to do business in England, their indigenous directors will use their influence to suit their system to the climate.

I have learnt in the course of this case one peculiar feature of the law of libel; it is that if you make a suggestion that a certain firm has failed to comply with the specification, as, for instance, by painting the dynamos the wrong colour, they, or their agent, may serve you with a writ for libel; but if they call you a liar, you have no redress.

John S. Raworth.

May 8th, 1895.

[It will probably be remembered that Mr. Kite threatened to include us as defendants in the above action.—Eds. Elec. Rev.]

A Protest.

Can nothing be done to reduce in some measure the flood of "classical" advertisement by which we have of late been almost overwhelmed? The *Proceedings* of the Civil Engineers, of the Mechanical Engineers, and of the Naval Architects, all contain "papers" by the same firm; and I have just received a notice from our own Institution of still another paper which is to be read shortly, also in praise, as I imagine, of the same apparatus. At a shareholder's meeting a lecture by the chairman on the beauties of one's own manufactures is perhaps not out of the way, and *that* we have already been treated to; and the correspondence columns of the technical journals can, as we have had ample evidence of late, be used to keep the name of a particular kind of engine well before the public; but ought not the councils of the various learned societies to hesitate before lending themselves to this sort of thing?

Unless the electrical press take the matter up we shall before long find, on opening our morning newspapers, a slip bearing the well known "Good morning, have you used our high-speed soap"; and, in the name of decency I ask again, "Can nothing be done to reduce the flood?"

Student.

London, *May 4th*, 1895.

BUSINESS NOTICES, &c.

Ready.—The Universal Electrical Directory. This directory for 1895, which is on sale at 22, Paternoster Row, by Messrs. H. Alabaster, Gatehouse & Co., contains a total of 20,958 distinct names of individuals and firms, being 2,500 more than were contained in the previous edition, and about 8,000 more than any other electrical directory published. In addition to the incorporation of new names, all have been carefully revised, much financial information has been added, the telegraphic addresses and local telephone numbers are given, and the total of pages in the work is increased by 80, making in all about 866 pages entirely of directory matter. Price 4s.

Akester Electric Syndicate, Limited.—The creditors of the above company are required, on or before June 10th, to send their names and addresses, and the particulars of their debts or claims, and the names and addresses of their solicitors, to J. Durie Pattullo, the liquidator of the company, at Nos. 30 and 31, St. Swithin's Lane, London, E.C

Bankruptcy Proceedings.—At a sitting of the London Bankruptcy Court, held on the 3rd inst., Wm. John Kelly attended before Mr. Registrar Brougham for public examination. He was examined by the official receiver particularly as to the circumstances under which the debts were contracted, and stated that he was appointed to the post of receiver of Poole & White, Limited, and acted throughout under the direction of Mr. Tryon, solicitor to the second debenture holders. With the exception of a small debt of £2 or £3, the whole of the liabilities were for goods supplied and used in the business of Poole & White, Limited. The orders were on printed forms, and a rubber stamp was used to which he added his written name as receiver. Some writs were served upon him in 1894, but they were all discharged. In February, 1895, the first debenture holders appointed a receiver who superseded witness in the business. Since leaving the premises he had not been served with writs, but he understood that documents of that character had been left at the works by substituted service. There was no ground for a suggestion that he had kept purposely out of the way, as his address was known to several persons at the works and could have been obtained by any inquirers. No blame had been cast upon him in the capacity of receiver, nor had it ever been suggested that the debts in question had been improperly contracted. The business had the benefit of all orders that had been executed. Witness did not contest a claim made by the Edison & Swan Company, and, in fact, he knew nothing about the action taken by that company for the recovery of the debt until judgment had been obtained. The bankrupt was further examined on behalf of creditors, and was eventually allowed to pass.

On 2nd inst., Loftus John Barnacle appeared on his adjourned public examination, and was further examined by the official receiver as to his accounts and also by Mr. J. W. Wall, on behalf of a creditor. A further adjournment was taken to the 16th inst.

Crossley Telephone Company.—A general meeting of the above company will be held at 41, Piccadilly, Bradford, on June 10th, at 2 o'clock precisely, for the purpose of having the Liquidator's accounts, showing the manner in which the winding up has been conducted and the property of the company disposed of, and to do business usual at such meetings.

Dining Cars.—The Great Northern Railway Company of Ireland's new dining car went on its trial trip last Saturday. The car is lighted from 25 C_9 type E.P.S. placed in suitable boxes underneath the car, which are charged by a stationary engine and dynamo at Belfast or Dublin termini. The lamps can also be lighted from accumulators in the guard's van, which are charged by a dynamo in the van, driven from the car axle. The car is lighted by incandescent lamps as follows:—Four 10-C.P. lamps in first class dining compartment, four 10-C.P. lamps in second class dining compartment, the lamps being fixed to ornamental polished brass brackets, fixed between the windows, one lamp lighting each table; a switch is fitted for each lamp beneath the bracket. Two vestibules, one 5-C.P. lamp each; two lavatories, one 2½-C.P. lamp each; kitchen, one 5-C.P. lamp; steward's pantry, one 5-C.P. lamp. Mr. Maurice Pitman, who has executed the work, also has a contract in hand for an installation of arc lamps, each of 2,000 N.C.P., at Messrs. Hampton, Leedom and Co., Henry Street, Dublin, and has just completed the electric lighting of Relt Tip, Limited, George's Street, Dublin, being an installation of incandescent lamps.

Dissolution of Partnership.—The partnership heretofore subsisting between G. H. Hardman, H. C. Ashworth and C. E. Lomax, carrying on business as wholesale and retail ironmongers and electrical and heating engineers, at 8, Fleet Street, Bury, under the style of H. Ashworth & Co. has been dissolved by mutual consent, so far as regards the said G. H. Hardman. All debts due and owing by the said late firm will be received and paid by H. C. Ashworth and C. E. Lomax, who will, in future, carry on the business in copartnership.

Electric Cooking.—Messrs. Crompton & Co., Limited, have just been awarded a diploma and gold medal for their electrical cooking apparatus at the Universal Cookery and Food Exhibition. This makes five diplomas and four gold medals, besides minor awards at continental exhibitions, within two years. In each case the awards have been made by experts in the art of cookery, and as a consequence the prizes should be of considerable value in recommending the adoption of the electric system.

Machinery User's Association.—The report of the Committee of this association for the year ended March 31st, 1895, was presented at the annual meeting held at Westminster Palace Hotel on Wednesday, the 8th inst., Sir Wm. Houldsworth, Bart., M.P., presiding. One of the objects of the meeting was to consider steps to be taken to secure a large majority for the third reading of the "Rating of Machinery Bill," on June 19th, and its success in the House of Lords. The Association seems to have had a very busy year, and its work so far has been crowned with a fair amount of success.

New Firm.—We learn that Messrs. H. Bulley, Charles A. Beckman, and W. E. Davies, lately with Messrs. D. Hulett & Co., Limited, of High Holborn, have commenced business as electric light engineers and contractors under the style or firm of Bulley, Beckman & Co., at 117, Charterhouse Street, E.C.

New Premises.—The Nalder and Harrison Construction Syndicate, Limited, notify us that owing to the large increase of business, and their intention to extend their field of manufacture, they have purchased the lease of the extensive premises known as the "Invicta" works, Bow Common Lane, E., together with the complete efficient engineering plant and machinery situated therein. They hope thus to be enabled to carry out work of the very largest and heaviest description, in addition to their present extensive output of electrical measuring and testing instruments, switchboards, &c. The syndicate intends to produce as soon as possible standard types of dynamos, motors, transformers, and steam engines, &c. As the work of transferring the existing plant at Trafalgar House and completing all new arrangements is of considerable magnitude, and one needing a certain length of time, it is intended to keep the works at Trafalgar House open until the new ones are as nearly as possible complete, in order that there may be no unnecessary delay in the execution of orders. Due notice of the final removal will be given, and in the meantime all communications should be addressed to the Head Offices at 47, Victoria Street, S.W.

New Process for Obtaining Alkali and Chlorine.—Some days ago, several local and other gentlemen inspected the new process for obtaining alkali and chlorine, developed by the General Electrolytic Company at their experimental works at Farnworth.

Price Lists.—Messrs. E. Ducretet and L. Lejeune, of Paris, have sent to us lists of Ferry's automatic connector and disconnector for charging accumulators, Grassot's system of electric intensity meter for continuous currents, and the pole seeker. All the lists are illustrated, and the descriptive matter is in English.

Smoke and Fumes Annihilator, Limited.—An extraordinary general meeting of this company was convened for Wednesday at the Cannon Street Hotel, for the purpose of considering and passing a resolution winding up the company voluntarily.

The E.N.S. Dry Battery.—The Electric Novelty Syndicate, of 7, Queen Victoria Street, and Bermondsey, are putting on the market a new dry cell which has every appearance of being a genuine article, well constructed, notwithstanding that the price at which it is offered is exceptionally low. The E.M.F. of the cell is 1·6 volt, and the internal resistance ·1 of an ohm. Polarisation is slow with normal working current, and recovery rapid on open circuit. The low resistance renders it suitable for many purposes to which dry cells have not hitherto been successfully applied. The E.N.S. cells are made in different sizes, round, square and rectangular, to meet various requirements.

ELECTRIC LIGHTING NOTES.

Ayr.—The Council are now inviting applications for supply of current from residents in the district, so that the necessary connections may be made.

Birkenhead.—The Council has accepted the tender of Messrs. Holme & Greene, of Liverpool, to erect the new chimney at the central station for the sum of £850, subject to certain conditions.

Bolton.—The Albert Hall is to be lighted by electricity. The Council are making application to the Local Government Board for sanction to borrow £3,000 for electrical and other purposes in the Town Hall.

Brighton.—According to minutes passed last week by the Council, we believe that tenders are to be invited for 45 lamp pillars of the same design as those at present on the King's Road. These 45 are for the Marine Parade, but tenders will be invited for 80 others of another design for other streets. The question of increasing the lighting in Regency Square has been deferred for the present, in view of the possible extension of the electric street lighting.

Bristol.—The whole of the Bristol Cathedral has been lighted by electricity. In the nave and choir there are 18 7-light pendants, designed by Mr. Pearson, R.A., and the light was on for the first time last Sunday evening, May 5th. The whole of the work was carried out by Messrs. F. W. Ball & Co.

Burton.—The mains are to be extended across the Burton Bridge and along the Ashby and Alexandra Roads.

Bury.—At the last Council meeting it was suggested that the managers of the gas works and of the electric lighting works should work in combination, inasmuch as "the electric light was not likely to be in as much request as they anticipated."

Cape Town.—We hear that Messrs. Siemens & Halske's electric lighting plant is now ready for work in Cape Town. Mr. Singer has had charge of the business of installation, on behalf of the Berlin firm.

Delhi.—The owners of the Ganesh Flour Mills, which have lately been erected at Delhi, contemplate fitting the buildings throughout for electric lighting.

Devonport.—The *Western Morning News* says that about 18 months ago the officials at Devonport received instructions to utilise the spare electric light plant in the dockyard for lighting ships in course of construction on the building slips. This was done, and the experiment has been so satisfactory that the Admiralty have now decided to spend a large sum of money in perfecting the arrangement, and when completed none but the electric light will be used on a ship from the time she is laid down until she is passed into the Fleet Reserve. During the present year it is intended to spend at Devonport £2,650 on additional plant, one half of which will be for perfecting the electric lighting arrangements of ships in course of building, and the other half for additional lighting plant to be used after the vessels leave the building slips.

Derby.—The Electric Lighting Committee has power to borrow £5,000 for electric lighting purposes.

Dover.—Preparations are being made to lay an electric light main down to the turret of the Admiralty Pier.

Dowlais.—The Gas Committee has declined to reduce its charges, and the tradesmen are anxious to have the electric light. The Dowlais Iron Company already supplies all its officials with electric light.

Eccles.—Before the Eccles Property Owners' Association on 24th ult., a lecture on "Electric Light *v.* Gas" was delivered by Mr. Wm. Broughton. The lecturer dealt with the subject popularly in regard to the proposals to light Eccles by electricity, rather than technically. He contended that the demand in the district for the light was by no means general. He proceeded to criticise Dr. John Hopkinson's figures given in his estimates, and gave figures of what he understood, from "his electrical friends," the scheme would cost. He dilated upon the cost of electric light as compared with gas. In the same number of the *Eccles Advertiser* as the report of the lecture appeared, there was a very able criticism from the pen of Mr. Geo. R Peers, A.I.E E., in which he calls Mr. Broughton over the coals for his vagueness and his inaccuracy, and produces facts and figures which prove Mr. Broughton to have been grossly misinformed, or to be very profuse in his exaggeration. We must mention that Mr. Broughton "did not pose as an electrician, but rather as an experimentalist of some years' standing." He has had his own residence lighted by electricity, but we question whether he has ever seriously read one of the electrical journals. It will be remembered that Mr. Clirehugh is the Council's present consulting engineer.

Edinburgh.—A local paper has an announcement asking contractors, who are willing to do electric wiring and fitting to specification in Edinburgh, to communicate with Prof. George Forbes.

The electric light is to be extended to Castle Terrace.

Electricity in Mining.—A contemporary devoted to the interests of South African trade says that electric light material to the value of £13,710 was used in 1894 by 57 Witwatersand mining companies who have given in their returns.

Grantham.—Messrs. Martin & Fitt, of High Street, have asked to be allowed to carry light cables across the streets for supplying electric light. The Council has decided not to grant Messrs. Martin & Fitt a general license, but to deal with each separate application on its merits.

Hull.—It is proposed to light some new baths in East Hull by electricity, and arrangements are also being made for electrically lighting the James Reckitt Library.

Johannesburg.—The Johannesburg Sanitary Board has decided to raise a loan of £225,000, for the purpose of purchasing additional machinery and the existing plant of the Johannesburg Lighting Company. Part of this amount will be spent on electrical plant.

Kendal.—At the last Council meeting a letter was read from the Chamber of Commerce enclosing a resolution asking the Council to consider the question of supplying the town with electricity for power purposes. The matter was recorded on the minutes.

Kingswood.—At the last meeting of the Urban Council, the chairman stated they had made arrangements with the police to report to the board every meeting night the lamps that were out both in the Hanham and Kingswood districts. They would while on duty record each lamp that did not give light, and to facilitate the arrangements, the lamps would be numbered. On the recommendation of the Works Committe, it was agreed that the extension of the electric lighting should be postponed for the present.

London.—The Board of Trade have decided to grant a provisional order to the County of London and Brush Provincial Electric Lighting Company, Limited, for power to supply electricity within the district of the St. Olave's Board of Works. The Board have also granted a provisional order to the Charing Cross and Strand Electricity Supply Corporation, Limited, for the electric lighting of the district within the jurisdiction of the Strand District Board of Works.

Newington.—At the Vestry meeting on Wednesday evening the Clerk reported that the Vestry's application for a provisional order had been successful. The Board of Trade had advised him that the House-to-House Supply Company would not, in consequence of the Vestry's action, proceed under its own order.

Oldham.—At the last Council meeting, the Electric Lighting Committee reported that Prof. Kennedy had estimated the additional cost of extending the electric light supply at £10,000. Alderman Smith said the original estimate was for £27,000, of which £25,550 had been expended. There had been so many applications for the electric light, that the Corporation had not the power necessary for the work, and it had become necessary to extend the cables to Werneth Park and along Huddersfield Road in an easterly direction.

Nottingham.—The Council Chamber and adjoining rooms at the Exchange Hall have been lighted throughout by electricity, several electroliers being among the fittings.

Pokesdown.—At a recent Parish meeting the question of gas *v.* electricity for lighting purposes was discussed. One of those present read an estimate from Messrs. Beigtheil & Young, in which they offered to light the district with twenty 10 to 12 ampère lamps for £730. That sum would include a dynamo, a gas engine to drive it, and the necessary apparatus, switches, cable, posts, &c. In addition to that sum the speaker explained there would be the cost of fixing the plant, which he estimated at £150. That would bring the total cost to £880. The annual expense, such as carbon, engineer's salary, gas for engine, &c., would be about £245. He suggested that the meeting should be postponed indefinitely until they got an urban council in office. This course was adopted.

Rottingdean.—The Parish Council has received an offer from Messrs. New & Mayne to supply and erect a number of electric lamps. The public are to be called together to consider the advisability of adopting the Lighting and Watching Act with a view to dealing with this offer.

Sheffield.—Upon the occasion of the visit of Royalty to Sheffield, a naval search light of about 40,000 C.P. is to be placed on the tower of the Parish Church by the local electric light company for the purpose of illumination.

Southampton.—The Works Committee have recommended the Town Council to obtain professional advice as to the value of the works of the Electric Light and Power Company at a cost of not exceeding 100 guineas.

South Africa.—We learn from a contemporary that an electric lighting plant is shortly to be ordered for the Wemmer mine.

The same contemporary says that electrical plant is on order for the North Randfontein Gold Mining Company. The Port Elizabeth Harbour Board has decided to light the warehouses electrically. An order for the lighting of Lourenço Marques by electricity will shortly be forthcoming.

St. Pancras.—An electric main is to be laid from University Street, along Gower Street, to the parish boundary, at a cost of about £214. The electrical committee are considering the question of extending the mains along Highgate Road and West Hill.

Torquay.—The Electric Lighting Committee recommend the adoption of Mr. Trentham's scheme for lighting by electricity the Bath Saloons, Strand, and adjoining portions of the town, at an initial cost of about £18,000. On Tuesday the Council rejected the recommendation. Application is being made for an extension of time under the provisional order.

Tottenham.—The question of electric lighting has been referred to the General Purposes Committee.

West Ham.—Inquiries are being made among the larger ratepayers to ascertain whether they will take a supply of current at, say, 6d. per unit, in the event of the Council installing a system.

Worcester.—Mr. Ruthven Murray having been appointed to have charge of the electricity works, the Streets and Water Committees recommend that Mr. Caink be relieved of the duties delegated to him so far as they relate to those works, and that his salary be reduced to £350 per annum, on the understanding that it be increased by £10 per annum until £400 is reached. This is equivalent to an immediate reduction of £100 per annum.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

American Railway Shares.—There are at present being offered for sale in this country $870,800 preference shares, at £21 per $100 share, payable on allotment, in the Twin City Rapid Transit Company of Minneapolis and St. Paul, Minnesota, U.S.A. The company's system consists of 225 miles, of which 219 are electric, and the rest cable. The subscription list will close to-day.

Birmingham Central Tramways.—In view of the antagonistic spirit for some time past rife among some of the shareholders of this company, Mr. Ebbsmith has perhaps done wisely in "desiring to be relieved of the duties of the chairmanship of the company." Mr. Neale has been unanimously elected chairman in his stead, but Mr. Ebbsmith will continue to act in the capacity of an ordinary director.

City and South London Extensions.—The Bill promoted for the extension of time within which to construct its authorised extension from Stockwell to Clapham Common has been referred to the Unopposed Bill Committee of the House of Lords, no petitions having been lodged against it. This Bill has already been sanctioned by the House of Commons.

Coventry Electric Tramways.—With regard to our "Note" last week, our readers will be interested to hear that the work has been begun. Mr. H. Lavington Fletcher, Assoc.M.Inst.C.E., is the resident engineer for the General Traction Company.

Electric Haulage for Collieries.—We learn that the Hickleton Main Colliery Company, Thurnscoe, is being supplied with electrical machinery in connection with a large endless rope haulage plant which they are fitting. The dynamo and motor are each capable of giving an output of 80,000 watts and 90 effective H.P. respectively. Messrs. Scott & Mountain, who have the work in progress, have fans and motors of their new type in hand for H.M.S. *Juno* and *Doris*, and other vessels. These fans are for the internal ventilation of the ships.

Electric Railways in America.—We occasionally hear of big electric railway schemes in America, and recently there have been several rumours about. The *Financial News* last week stated that the Metropolitan Electric Street Railway Company has been incorporated in Illinois, with a capital of over £1,000,000.

The same newspaper says that an application is to be made to the Canadian Parliament for the incorporation of a company to be called the International Railway Company, which proposes to build electric railway lines in various parts of Western Ontario, and to carry on other operations.

Electric Tramways for Roumania.—A 38 years' concession has recently been granted to a French firm for the construction and operation of a line of electric tramway on the accumulator system in the town of Galatz.

Electrically-propelled Vehicles.—In the House of Commons the other day, in reply to Mr. Naoroji, who asked whether the President of the Board of Trade proposed to take steps for allowing vehicles propelled by stored electricity or petroleum, if unobjectionable to the public, to be freely used in this country, Mr. Shaw Lefevre said he was about to introduce a Bill dealing with the subject.

Electricity in Mining.—The *South African Export Gazette* says that Messrs. Mather & Platt, Limited, have supplied to the Princess mine two 70-H.P. electric motors for driving the hoists, the mine pumps, and the battery pumps.

At the Salisbury mine the pumping plant, the tailings pump, and the cyanide gear are to be driven by electricity.

The machinery for the mechanical haulage of sand, elevating and lighting in the new cyanide plant at the Jumpers mine is driven by two Elwell-Parker dynamos and motors, operated by a 10-H.P. compound engine.

Madras Tramways.—We hear that the consulting engineer to the Indian Government for railways has reported that there is no impediment to the Madras Electric Tramways line being opened for public traffic, and that no danger will attend its use.

TELEGRAPH AND TELEPHONE NOTES.

A Telegraph Cable Wanted.—In the House of Commons on 6th inst., Mr. Arnold Morley said that about four years ago a request was made that a telegraph cable should be laid to the island of Sark, but as the estimate of revenue fell far short of the estimate of expenditure, the Treasury did not see their way to sanction the extension.

African Telegraphs.—We understand that orders have been placed for the material necessary for the extension of the telegraph from Blantyre to Tanganyika, a distance of 700 miles.

Cable Concessions.—The concessions held by the Compagnie Française des Câbles Télégraphiques from the Government of Venezuela, giving exclusive rights to transmit telegrams between the United States and Venezuela for a term of 20 years, dating from July 26th, 1887, have recently been extended to cover a period of 50 years from that date, and in addition the company have acquired the exclusive right to lay coast cables between the different ports of Venezuela.

Corrections.—In our report of the April 26th sitting of the Parliamentary Committee, a slight error occurred. *Sir* Grant Lawson, our readers will have observed, should have read Mr. Grant Lawson.

Also in line 21 of Major S. Flood Page's statement it was inadvertently reported "that there should be *no* obligation." Instead of *no* read *an*.

India.—An Indian contemporary remarks that the sum of Rs. 20,500 has been provided in the current estimates for the maintenance of electrical communications in connection with the defence works at Aden.

The Telephone Service.—The Highways Committee of the London County Council are circularising the users of the telephone in the Metropolis, asking for details as to their opinion of the efficiency or otherwise of the present telephone service. It would seem that the object of the circular is to obtain as many testimonies as possible deprecating the present system, with a view to proving before the Parliamentary Committee that the National Company does not do as much as possible in the interests of its customers. The National Telephone Company is also circularising its subscribers, asking whether the present service is not a reasonably efficient one. The City Commissioners of Sewers are likewise sending out a list of questions.

"Practical Telephony."—A new and well written series of articles, entitled "Practical Telephony," is now appearing weekly in the columns of our contemporary, *Electricity*. The series is being written by Messrs. James Bell, A.I.E.E., and S. Wilson, and should interest a very large number of readers, especially in view of the inquiry now being held by the Government.

Provincial Authorities and the Telephone Agreement.—The Aberdeen Chamber of Commerce, and the Dumfries Town Council, at meetings held in their respective towns, considered the question of the Government acquiring the telephone system. The former body were divided as to whether to support the purchase or not, and it was thought premature to pass any resolution on the matter. The Dumfries Council, however, decided to petition Parliament in favour of the purchase, and also in favour of laying underground telegraph cables.

The Pacific Cable.—It was stated in the House of Commons the other day by Mr. Sydney Buxton, that Her Majesty's Government had not received any request from or through the Government of Canada to call a conference of the Colonies interested with a view to arranging the details of the laying and maintenance of a cable across the Pacific Ocean between Canada and Australasia.

Telegraph Rates to the East.—From the accounts submitted to the Eastern Extension Telegraph Company's shareholders at their meeting held last week, under the presidency of Sir John Pender, the chairman of that company, we gather that the gross receipts for 1894 were £509,003, or practically the same as in 1893. This figure which, of course, includes subsidies and guarantees, shows that this company has lost little or nothing by the reduction of rates to Australia, which was forced upon it owing to the possibility of a competing system across the Pacific. While the income of the company has not suffered, it is gratifying to know that, as was pointed out in the Hobart Conference, "the saving already effected to the customers of the cable by the reduced rates amounted to £200,000." Of course, a portion of this saving is discounted by the necessity under which the Australasian colonies lie of handing over a certain amount as guarantee to the Eastern Extension Telegraph Company. This amount, however, has been gradually decreasing, and with an efficient service, will probably soon be annulled, thus proving the advantages of low rates. We observe from press reports of the Postal and Telegraphic Conference of Australasia, recently held at Hobart, that the basis on which the "guarantee of traffic" was founded in 1891, viz., a yearly total of £191,000 has been increased to £227,000 per annum, and that the Colonies undertake to make up to the company any loss below that amount not exceeding £10,000 per annum (they also guaranteeing a revenue of £20,000 on the New Zealand cables), the rates to remain the same as at present; this arrangement to be carried on from year to year. This proposal, doubtless the result of past experience, is a clear verdict in favour of low rates, and an encouragement to further experiment in that direction. In examining the present rate for telegrams to Australia, we find a good deal of light thrown on the matter by the chairman of the Eastern Extension Telegraph Company in his address to the shareholders in April, 1890 (before the rates were lowered), where, in dealing with a proposed reduction in tariff, he points out that "the outpayments alone, without giving any return to the Eastern Extension Telegraph Company for its enormous system, amounted to 4s. 10d." At the present time the rate to Adelaide is 4s. 9d., and as the amount received from the colonies as "traffic guarantee" last year was only £6,200, it is apparent that some change must have taken place in the amount of the "out payments." The position at present, as far as we can gather, stands as follows:—A telegram from Adelaide to London costs to the public 4s. 9d. per word. Of this amount, 7d. is due to the South Australian Government for transit rate, and 1½d. to Java. Now, the cable system of the Eastern Extension Telegraph Company terminates at Madras; and from Madras to London the cost is 4s. per word. From this it is evident that, unless the Eastern Extension Telegraph Company has an arrangement with the lines running from India to London, this company only receives ½d. per word for Adelaide messages carried over about 4,000 miles of their cable. It is, however, impossible to conceive that the Chairman of the Eastern Extension Telegraph Company (who is described by the President of the Hobart Conference as "one of the astutest men in the Empire") has not come to some arrangement with the lines running west from India, by which the Eastern Extension Telegraph Company get more than a halfpenny per word for their Australian traffic. Any such arrangement would, unfortunately, however, have the effect of diminishing the facilities which the Eastern Telegraph Company and the Indo-European Telegraph Company should have for decreasing the rates from India to London. In this rate, as pointed out by Mr. E. O. Walker (late of the Indian Telegraph Department), "there has been practically little reduction in cost per word for 20 years," and it would certainly seem inequitable that the telegraphing public in India should be tied down to a high rate in order to afford facilities for the reduction of rates to Australia.

Telephones in Mills.—The *Miller*, in a note headed "March of the Telephone," makes much of the connection of St. Mullin's Mills, in County Kilkenny, with the post office at the neighbouring town of Graigue, by telephone.

CONTRACTS OPEN AND CLOSED.

OPEN.

Birkenhead.—May 23rd. Tenders are invited for the supply and erection complete of the following apparatus and plant, for the Corporation—namely: Section C—three Lancashire steel boilers, &c., at the electricity station, Bentinck Street, Birkenhead; Section D—three sets of engines and dynamos, &c., at the station; Section E—a storage battery and connections, &c, at the station; Section F—electrical and other instruments at the station; Section

G—cables, street boxes, &c., in certain streets in the borough. Particulars obtainable from the Town Clerk, at the Town Hall, or from Mr. J. N. Shoolbred, of 47, Victoria Street, S.W.

Brazil.—The Municipal Authorities of Santos, St. Paulo State, Brazil, are inviting tenders for the supply of plant for the electric lighting of the town. The central station will be situated at a distance of 18 kilometres from the town, it being intended to utilise the power (about 1,200 H.P.) of a waterfall.

Brighton.—May 13th. The Borough Council are inviting tenders for India-rubber lead-covered cables.

Brighton.—May 13th and 27th. The Corporation invite tenders for arc lamps, &c., and boilers.

France.—May 25th. The Prefecture of Saint Lô, at Cherbourg (Manche), is inviting tenders for the operation of electric tramways in Cherbourg.

Holland.—June 1st. The Dutch Telegraph Department in Amsterdam is inviting tenders for the supply of 600,000 kilogrammes of paper slip for Morse telegraph instruments.

Londonderry.—June 1st. Tenders are being invited by the Corporation for carbons. Details to be obtained from the town clerk, Mr. R. Chambers, at the Guildhall.

Manchester.—May 13th. Tenders are invited for the supply, delivery, and erection, complete, of the electric lighting machinery and installation for the efficient lighting of the new foreign animals wharf at Mode Wheel, for the Corporation. Details can be obtained from Mr. T. de Courcy Meade, City Surveyor, Town Hall, Manchester.

Rangoon.—November 4th. The Municipal Committee is inviting tenders for electric lighting. Particulars to be obtained from Messrs. Ogilvy, Gillanders & Co., 67, Cornhill, E.C.

Shoreditch.—May 20th. Tenders are invited for dust destructor furnaces for electricity supply.

Tunbridge Wells.—May 28th. The Corporation are inviting tenders for the wiring of the municipal buildings, in accordance with the specification prepared by the electrical engineer. Full particulars to be obtained from the Town Clerk at the Town Hall.

CLOSED.

Burnley.—Tenders for the following works and machinery required in the extension of the electric lighting station, at the prices named, have been accepted: Thomas Smith, excavator, mason, and bricklayer's work, £403; John Hanson, carpenter and joiner's, £66; Burnley Ironworks Company, Limited, 250 I.H.P. horizontal engine, £900, and exhaust pipes, planing engine beds, additional floor plates, &c., £75; Electric Construction Company, Limited, dynamo and switches, £535.

Rouen.—A contract has just been given out by the Société Normande d'Electricité for four Willans triple expansion engines, each of 180 H.P., for its central station at Rouen.

BOOKS RECEIVED.

Electricity in our Homes and Workshops. By Sydney F. Walker. Third Edition. Published by Messrs. Whittaker & Co., London. Price 6s.

Petroleum: Its Developments and Uses. By R. Nelson Boyd. Published by Messrs. Whittaker & Co., London. Price 2s.

The Practical Telephone Handbook. By J. Poole. Second Edition. Published by Messrs. Whittaker & Co. Price 5s.

NOTES.

The World's Telegraphs.—In continuation of the statistics of the World's telegraphs for 1893, given in the issue of *Journal Télégraphique* for November 25th, 1894, the issue for April 25th gives information with reference to Great Britain, Russia, and the United States of America, as follows:—Great Britain and Ireland: Length of line, 56,317 kilometres; length of wire, 343,514 kilometres; offices, 9,210; instruments, 26,764; staff, 136,111; telegrams, 73,299,237; receipts, 63,356,625 francs; expenditure, 63,934,150 francs; population, 38,520,116; area, 77,828,829 square kilometres. Russia: Length of line, 126,273 kilometres; length of wire, 249,215 kilometres; offices, 2,133; instruments, 4,334; staff ——; telegrams, 13,193,257; receipts, 47,724,832 francs; expenditure, ——; population, 120,000,000; area, 22,434,392 square kilometres. United States of America: Length of line, 306,387 kilometres; length of wire, 1,273,175; offices, 21,166; instruments, ——; telegrams, 58,632,237; receipts, 109,263,275 francs; expenditure, 80,300,851 francs; population, ——; area, ——. (The statistics marked —— are not given.)

Acetylene Gas.—Under date of April 23rd, a well-known American writes from New York as follows:—"Some time ago there arose a new craze here (you know we Yankees can beat the world at that sort of thing) in reference to what was called 'the recent new discovery' of acetylene gas, manufactured from calcium carbide. I saw your paper, and notice that, as usual, you were on the right side, and pursuing your usual conservative course in reference to the new matter. If you have seen the recent numbers of the *American Gas Light Journal*, and other publications of a scientific nature on this side, you will have noticed that it has about run its course here, and that it may soon take its place with the Keely motor, *et id genus omne*. You Englishmen do not get into race so soon as we, but you are great stickers when you once start out; so I shall expect to see quite a lot of good English shekels gathered in still before the bubbles burst. I have taken quite an interest in the thing myself, and having had some sad experience with the reduction of the refractory oxides and metals in the days gone by, I was anxious to learn the secret of the philosopher's stone, by which such astonishing results were achieved. I was unable to understand how in the name of all that is good, in view of Moissan's and Maguenne's experiments and publications, it was possible to patent their work after three or four years, and also to learn how the price could be made so low. But the suckers are nearly all caught here now, and we are getting down to something like bottom prices. These have been steadily rising since the publication of Prof. Lewes's articles, and the accompanying document will give you an idea of the very lowest price that the stuff can be had for export. Is not that a difference from what the fairy tales of the Electro Gas Company had led the unsuspecting to expect? I have not been an enthusiast on the prices quoted by the gas concern, and so my name was not good enough to get a genuine quotation, so as to S. M. Hugh, all I have to say is, 'Them's me.' P.S.—Eimer & Amend is the title of one of the largest chemical firms that we have in this country, and are the general agents for the sale of calcium carbide. As to the amount of carbide to be had, I may say that at his lecture before the American Institute last Thursday, Prof. Laudy, of the Columbia School of Mines, said that he had 'cornered the market' by his order of 25 lbs., being only able, after a lot of trouble, to obtain 10 lbs."

Eimer & Amend, Manufacturers and Importers of Chemicals and Chemical Apparatus,
205 to 211, Third Avenue, corner of 18th Street.
New York, *April 19th*, 1895.

Mr. S. M. Hugh, New York, N.Y.

Dear Sir,—In reply to your letter in which you say that the calcium carbide is to be used for chemical purposes, and not for heat, light, or power, we are pleased to quote:

1 ton lots, at		12 cts.	per lb.
5	"	10	"
10	"	9	"
20	"	8	"

freight paid to N.Y., and $10 extra for water-tight drums holding about 1,200 lbs. each, and shall be pleased to receive your order for the same. The delivery would be subjected to the limitation of output, as the great many calls for this material may cause delay in furnishing. It would be well, therefore, to place your order as soon as possible, to get ahead of others.

Yours respectfully,
Eimer & Amend,
per E.

Lectures.—At the last meeting of the Liverpool section of the Society of Chemical Industry, held in University College, a paper was read by Dr. Hurter on "The Efficiency of Electrolytic Apparatus."

The Association of Municipal and County Engineers visited Brighton on Saturday last, and a paper was read by Mr. Arthur Wright on "Points of Interest in the Development of Electricity Supply at Brighton."

Expression for Electro-Magnetic Force.—In a communication addressed to us, Prof. Silvanus P. Thompson says that the method of Hutchinson and Carichoff referred to in our last leaderette on page 526, has been taught to his students for the past 11 years, and is also referred to on pages 334 and 335 of his last edition of "Elementary Lessons."

A 5 per Cent. Commission.—

Eminent Consulting Engineer (*emerging from railway station in north country town, espies a small boy crossing the road*):—Hi, boy! Can you tell me where the electricity supply works are?

Boy *in the dialect of the district indicates the direction.*

E. C. E. (*proceeding on his journey with a dim notion as to where the electric light works are, resolves to be on the look-out for a tall chimney*). *Sotto Voce:* I recommended a combination of boilers and dust destructors here. Not sure whether they use tall chimneys under such conditions.

E. C. E. *inquires of several natives, whose ignorance of his personality somewhat amuses E. C. E.*

After considerable trouble arrives at the central station; its propinquity to a river strikes him as an admirable arrangement.

Resident Engineer, known as Clerk of Works (*descrys him crossing the space in front of the station, rushes out to greet E. C. E.*—Good morning, sir.

E. C. E. (*greeting R. E. with effusion*).—How do you do? (*They pass into the works, E. C. E. breathless with surprise at their advanced state.*) Really, Mr.——Mr.——

R. E.—Atkins.

E. C. E.—Really, Mr. Atkins, I have nothing but congratulations to offer on the progress you have made. (*Begins to examine machinery in detail*). Oh, Leeman's dynamos! I thought we were going to have Smith's.

R. E.—That was the original intention, but if you remember, Mr. Groger, the Chairman of the Electric Lighting Committee, suggested that it might be better to have——

E. C. E.—Yes, yes! I remember! Let me see, the engines are——

R. E.—Horizontal compound condensing.

E. C. E.—(*Noticing name of makers*) Messrs. Dicks, seem to have made them very well.

They pass on to inspect switchboard. E. C. E. finds a difficulty in understanding it, and proceeds to the boiler house, is charmed with Buckley's stoker and coal conveyer.

E. C. E.—Really that is most excellent. I had no idea that Buckley's had worked out their system so completely.

R. E.—I am afraid that I took a liberty with regard to that. You specified Johnson's mechanical stoker, but they never work properly, and Mr. Groger agreed with me that it was desirable to have something that was useful, and we (Mr. Groger and I) thought that you would not object to Buckley's.

E. C. E.—Quite right! You could not have done better. (*Thinks what a very useful man Atkins is.*) I should like to see the dust destructors now.

R. E.—That is the one thing we are most behindhand with. We have commenced on them, but Mr. Groger has been reading some articles in the technical papers, and thought it best not to commit ourselves too deeply, so we have not done much during the last few days.

They go out and contemplate a melancholy heap of bricks at the rear of the works.

E. C. E.—After all there is no hurry for this (*indicating the embryonic dust destructor*). I suppose everything else will be ready for next Friday's ceremony.

R. E.—Oh, yes; but when do you propose to make the tests.

E. C. E. (*in a hurried manner*).—I don't think that will be necessary. I suppose the makers have had the machines running. You might, perhaps, make a few rough tests yourself, and tell me how they come out. I shall be here on Wednesday night! By the way, you had better meet me at the George and have some dinner with me. I must now rush off to catch the 1.15. Good-bye.

Takes his departure after a prolonged stay of 15 *minutes.*

R. E. (*sotto voce*).—The bounding old humbug! Suppose he thinks he's designed the station. (*Reflects with a sigh that at any rate he'll get the fee.*)

E. C. E. on his way to station makes approximate calculation as to what 5 per cent. on £65,000 *is.*

Friday's ceremony passes off with *éclat. Everybody astonished at the grasp which E. C. E. has of electrical matters. Resident Engineer in the background philosophises on "cheek."*

Royal Institution.—The annual meeting of the members of the Royal Institution of Great Britain was held on May 1st, Sir James Crichton-Browne presiding. Sixty-two new members were elected in 1894, and 63 lectures and 19 evening discourses were delivered. The following gentlemen, among others, were elected as officers for the ensuing year:—President—The Duke of Northumberland, K.G.; treasurer—Sir James Crichton-Browne; secretary—Sir Frederick Bramwell, Bart.; managers—Sir Frederick Abel, Bart., K.C.B., Captain W. de W. Abney, C.B., Sir Benjamin Baker, K.C.M.G., Messrs. William Crookes, John Hopkinson, the Marquis of Salisbury, K.G., Mr. J. W. Swan; visitors—Messrs. Victor Horsley, Silvanus P. Thompson, and others.

Technical Schools.—The *Record of Technical and Secondary Education* gives in its April issue several good photographs of laboratories and other departments at provincial technical schools, notably that at Sheffield.

Will the Electric Motor Supersede the Steam Locomotive?—In *Scribner's Magazine* for April, there is an article on the above subject from the pen of Mr. Joseph Wetzler. The writer discusses the various points for and against the two systems, and chronicles changes which are being made by steam railway companies in the States in favour of electricity. Summing up the whole matter, in the light of recent developments over there and of the advantages of electricity, Mr. Wetzler is bold enough to remark that he firmly believes all railroads will be eventually operated by electricity. He touches an important point when he says, wisely enough, that cheap transportation is more essential than great speed, which is but a secondary consideration, though so much has recently been said about it.

Action Against St. Pancras Vestry.—In the Bloomsbury County Court, on Wednesday, Mr. Elton, whose premises are at the corner of Endsleigh Gardens and Euston Road, claimed £40 for damages done to a wall and outside lamp by the explosion which occurred in the Vestry's main boxes on December 29th, at midnight. He secured a verdict against the Vestry for £2 3s., and costs.

The Northern Society of Electrical Engineers.—At the meeting on Monday, May 13th, a paper on "The Uses of Accumulators" will be read by J. C. Howell, Esq.

Society of Arts.—On Wednesday evening, May 8th, a paper on "The Extraction of the Rarer Metals from their Oxides" was read by Prof. W. Chandler Roberts-Austen, C.B., F.R.S.

Argon.—*Science Gossip* for May has an article by Messrs. J. Alfred Wanklyn and W. J. Cooper, entitled "Notes on Argon." The experiments of Lord Rayleigh and Prof. Ramsay are criticised, and instances are given where the spectroscope has been misused with disastrous results. The article concludes with these words: "In years gone by the metal of common lime was mistaken for something new by an operator, and later on two other very eminent men of science discovered the apocryphal metal, jargonium." *Science Gossip* is now published by Simpkin, Marshall & Co., and appears monthly. It contains many articles of interest to science lovers, and is well illustrated.

The Institution of Electrical Engineers.—At a students' meeting to be held in the Library of the Institution, 28, Victoria Street, on Friday, May 17th, 1895, at 8 p.m., a paper will be read on "Aluminium," by Gerald C. Allingham.

Institute of Engineers and Shipbuilders.—This Institute has agreed to grant a premium of books to Mr. Wm. Arnot for his paper on the "Glasgow Central Electric Light Station."

Fatal Accident in Cincinnati.—A Dalziel telegram says a horrible fatal accident occurred in one of the main thoroughfares in Cincinnati on Saturday morning. A man while working at the top of an electric light pole slipped and fell on the wires in such a position that he could not extricate himself. His neck rested across one of the naked wires, which gradually burnt its way through it until the head dropped to the ground.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Edison-Bell Phonograph Corporation, Limited (37,655).—The usual return of this company was filed on April 1st, when all the capital of £60,000, in £5 shares, was taken up. Of these shares 4,000 were issued as fully paid, and £40,000 has been called and paid in respect of the remainder.

Electrophone, Limited.—The annual return of this company was filed on April 2nd. The capital is £20,000, in £5 shares, of which 1,584 are taken up. 500 have been issued as fully paid, and £2 5s. per share has been called on 1,084 shares. £1,005 10s has been paid, and £1,420 10s. still remains to come in.

Electrical Installation Company, Limited.—The annual returns of this company for 1894 and 1895 were both filed on March 26th. In the former 2,800 shares, of £1 each, were taken up, and paid for in full, and in the latter 3,300 shares, constituting the whole of the capital, were subscribed for, and £3,300 paid.

Electrical Accessories Company, Limited.—The annual return of this company was filed on February 14th, when 2,257 shares were taken up out of a capital of £5,000, in £1 shares; 1,500 of these have been considered as paid, and the full amount has been called and paid on the remainder.

House-to-House Electric Supply Company, Limited (25,913).—The annual return of this company was filed on February 28th. The capital is £350,000 in £5 shares (57,900 ordinary, 100 founders', and 12,000 preference), 8,322 ordinary, 100 founders', and 5,000 preference have been taken up, and 100 founders' and 1,000 ordinary have been issued as fully paid. The full amount has been called and paid on the remainder.

Keswick Electric Light Company, Limited (28,820).—The annual return of this company was filed on April 1st, when 3,420 shares were taken up out of a capital of £5,000 in £1 shares. The full amount has been called and £3,420 paid.

Lancashire and Yorkshire Electric Lighting Company, Limited (17,486).—The annual return of this company for 1894 was filed on April 2nd. The capital is £100,000 in £5 shares. 127 have been taken up, £2 10s. per share called, £315 paid, and £2 10s. is still unpaid.

Liverpool Electric Supply Company, Limited (17,760).—The annual return of this company was filed on March 21st. The capital is £300,000 in £5 shares; 50,000 have been taken up, and £250,000 paid.

Lowcock, Hill & Co., Limited (42,692).—The statutory return of this company was filed on April 24th. The capital is £15,000 in £10 shares; 407 have been taken up, and 400 issued as fully paid. The full amount has been called on the others, but nothing has been paid.

Froggatt's Electric Lighting Company, Limited (40,321).—The registered office of this company was removed, by notice dated March 9th, to 2, Lorrimore Street, Walworth, London, S.E., from 55, Thomas Street, Kennington, S.E.

European Sims-Edison Torpedo Company, Limited (33,976).—The annual return of this company was filed on February 4th, when 7,880 ordinary shares and 1,000 founders' shares were taken up out of a capital of £201,040, divided into 10,000 ordinary shares of £20 each, 1,000 founders' shares of £1 each, and 40 preference shares of £1 each; 7,350 ordinary have been issued as fully paid, and the full amount has been called on the remainder, £10,458 has been paid, and £1,142 still remains to come in.

Ogmore Valley Electric Light and Power Supply Company, Limited (34,191).—The annual return of this company was filed on April 6th, when 710 shares were taken up out of a capital of £10,000, in £5 shares. The full amount has been called, £3,353 has been paid, and £197 remains to be sent in.

Notting Hill Electric Lighting Company, Limited (25,921).—The annual return of this company was filed on March 21st. The capital is £100,000, in £10 shares (6,452 ordinary, 550 founders', and 2,998 ordinary preference). 6,452 ordinary, 550 founders', and 1,370 ordinary preference have been taken up, and had the full amount called, while 367 ordinary preference have been taken up, and 10s. per share called, the whole resulting in the payment of £83,903 10s.

Mexican Gas and Electric Light Company, Limited (18,223).—The annual return of this company for 1894 was filed on April 17th. The nominal capital is £100,000, in £20 shares, of which all have been taken up, and all issued as fully paid.

Midland Electric Light and Power Company, Limited (16,166).—The annual return of this company was filed on April 22nd. The capital is £50,000, in £10 shares. 3,139 shares have been taken up, and 3,132 shares have been issued as fully paid. £70 has been paid on the rest.

CITY NOTES.

Dover Electricity Supply Company.

THE first annual meeting of the Dover Electricity Supply Company was held at the offices on Friday, May 3rd, when the CHAIRMAN (Sir W. H. Crundall, Mayor of Dover) presided, and was supported by Mr. C. W. Bagshawe, J.P., and Mr. B. H. Van Tromp (directors), and a large number of local shareholders. The report stated that the contracts for the generating station buildings, offices and street work had been completed, and part of the generating plant delivered and erected, so that the company had been enabled to commence the supply of current under the contract with the Corporation for the public lighting of the streets. A contract with the War Office, for the lighting of the gun turret on the Admiralty Pier, and several contracts with private consumers had also been entered into. At the present time the lamps connected and applied for were equivalent to 2,200 8-C.P., and the directors believed that, by the end of the year, they would have the equivalent of 5,000 8-C.P. lamps connected to the mains. Inquiries had also been addressed to the company as to the supply of power for working cranes and hoists, and they hoped to obtain a considerable addition to ordinary revenue from this source. In proposing the adoption of the report, Sir W. Crundall mentioned that £25,000 had been taken up in shares of the company. The amount expended on the works had been, up to the present, £46,000. As to the amount to be charged for the light, this would be 8d. per Board of Trade unit, but if the light were well taken up, this could be reduced to 5d., making the cost equivalent to gas in Dover. He hoped the time was not far distant when they could declare a dividend.

The report was adopted and the retiring directors re-elected.

The Brazilian Submarine Telegraph Company, Limited.

THE report of the directors for the half-year ended December 31st, 1894, to be submitted to the forty-third ordinary general meeting, May 15th, 1895, states that the revenue for this period amounted to £104,926 0s. 7d., and the working expenses to £36,771 18s. 2d. After providing £4,841 6s. 8d. for debenture interest and sinking funds, and £1,490 0s. 9d. for income-tax, there remains a balance of £61,822 15s.; to this is added the sum of £1,501 5s. 9d. brought forward from June 30th last, making a total of £63,324 0s. 9d. First and second interim dividends, amounting to £39,000, have been paid, and £20,000 transferred to the reserve fund, leaving the sum of £4,324 0s. 9d. to be carried to the next account. The receipts for the half-year include the sum of £1,500 dividend to June 30th, 1894, on the company's shares in the African Direct Telegraph Company, Limited. The directors, with much regret, have to report the death on the 3rd inst. of their esteemed colleague, Mr. Thomas Fuller, who has been managing director of the company from the date of its formation. The various sections of the company's line are in good working order.

Morecambe Electric Light and Power Company, Limited.

THE fourth annual meeting of shareholders was held at the Assembly Rooms, Morecambe, on Saturday last, the proceedings being conducted in private. Mr. C. M. Mabbott, chairman of the company, presided, and there was a fair attendance. The report showed a loss of £424 14s. 5d., mainly due to loss on supply of current consequent on the "scale system" of annual charges per lamp being unremunerative. This had been a serious mistake, and would be abandoned forthwith in favour of supply by meter. Law costs and fine for nuisance accounted for £48 12s. 8d. The conviction for nuisance had necessitated the removal of the premises to a non-residential part of the town, and for this it was proposed to raise £1,800 of preferential capital. The report and balance-sheet were adopted.

The Western and Brazilian Telegraph Company, Limited.—The directors, subject to final audit, have decided, after placing £8,000 to the reserve fund and £5,000 to the debenture redemption fund, to recommend at the forthcoming meeting of shareholders the payment of 6s. per share, free of income tax, making, with the interim dividend paid in November last, a total distribution of £3 per cent. for the 12 months ended December 31st, 1894. This will give 6s. to the ordinary, 4s. 6d. to the preferred ordinary, and 1s. 6d. to the deferred ordinary shareholders.

Stock Exchange Notices.—The Stock Exchange Committee have appointed Thursday, May 9th, as a special settling day in the County of London and Brush Provincial Electric Lighting Company, Limited, 2,475 ordinary shares, Nos. 20,001 to 22,475, and 10,000 6 per cent. cumulative preference shares, Nos. 40,001 to 50,000; and ordered the undermentioned securities to be quoted in the Official List:—County of London and Brush Provincial Electric Lighting Company, Limited, 22,475 ordinary shares, Nos. 1 to 22,475, and 10,000 6 per cent. cumulative preference shares, Nos. 40,001 to 50,000.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending May 5th, 1895, amounted to £864; week ending May 6th, 1894, £887; decrease, £23; total receipts for half-year, 1895, £16,983; corresponding period, 1894, £16,401; increase, £582.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of April, 1895, amounted to £1,942, against £1,742 in the corresponding period of last year.

The Great Northern Telegraph Company. The traffic receipts in April, 1895, were £27,600; January 1st to April 30th, 1895, £95,600; corresponding months, 1894, £83,000; corresponding months, 1893, £84,000.

The Liverpool Overhead Railway Company. The receipts of this railway for the week ending May 5th, 1895, amounted to £1,148; corresponding week last year, £874.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending May 3rd, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,891.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation May 1st.	Closing Quotation, May 8th.	Business done during week ended May 8th, 1895. Highest.	Lowest.
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	...	4 %	4 %	101 —104	101 —104	...	...
1,012,880£	Anglo-American Teleg., Ltd.	Stock	£2 15s.	£2 11s.	£2 2s.	44 — 46	45 — 47	44½	...
2,993,560£	Do. do. 6 % Pref.	Stock	£5 10s.	£5 2s.	£4 4s.	81½— 82½	84 — 85	84¾	81⅝
2,993,560£	Do. do. Defd.	Stock	...	...	...	7¾— 8½	8½— 9	8	7⅞
130,000	Brazilian Submarine Teleg., Ltd.	10	6½% §	6½% §	...	12½— 13	12½— 13	13	12 9/16
75,000£	Do. do. 5 %, repayable June 1906	100	5 %	5 %	...	110 —114	110 —114	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 40,000	5	10%‖ §	... §	...	3 — 4	3 — 4	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	148 —152	148 —152	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	2 % §	2 % §	...	1/16— 3/16	1/16— 3/16	1/8	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	13 — 14	13 — 14	13½	13⅜
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	20 — 21	20 — 21	...	...
12,931	Direct Spanish Teleg., Ltd., £4 paid	5	4 %	4 %	4 %	3½— 4½	3½— 4½	...	...
6,000	Do. do. 10 % Pref.	5	10 %	10 %	10 %	9¼— 10¼	9¼— 10¼	...	...
30,000£	Do. do. 4½ % Debs of £50, Nos. 1 to 1,600	...	...	...	4½%	103 —106%	103 —106%	...	...
60,710	Direct United States Cable, Ltd., 1877	20	3½% §	2⅝% §	2 %	9 — 9½	9¼— 9⅜	9⅜	9
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½% §	...	16¼— 16⅜	16¼— 16⅜	16 5/16	16⅛
70,000	Do. 6 % Pref.	10	6 %	6 %	...	17¼— 17⅜	17¼— 17⅜	17¼	...
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	...	105 —108	105 —108	...	...
1,297,837£	Do. 4 % Mort. Deb.	Stock	4 %	4 %		124 —127	124 —127	125	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	17⅛— 17⅜	17⅛— 17⅜	17⅜	17⅛
54,100£	{ Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326 }	100	5 %	5 %	5 %	103 —107	103 —107	...	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5 %	104 —107	104 —107	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	123 —126	123 —126	125¾	124
95,100£	{ Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343 }	100	5 %	5 %	5 %	103 —107	103 —107	...	...
129,100£	Do. do. do. to bearer, 2,344 to 5,500	...	5 %	5 %	5 %	104 —107	104 —107	106	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 2,016, red. 1909	100	4 %	4 %	4 %	106 —109	106 —109	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	112 —115%	110 —113%	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅜% §	4⅜% §	...	9⅞— 10⅛	9⅞— 10⅛	10⅛	9 13/16
180,042	Do. do. 6 % Pref.	10	6 %	6 %	...	16⅜— 16⅞	16⅜— 16⅞	16⅞	16⅜
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜%	8⅜%	8⅜%	21½— 22¼	21¾— 22¼	21 15/16	21⅞
190,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	105 —108	105 —108	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	51 — 53	50 — 52	51½	50½
37,548	London Platino-Brazilian Teleg., Ltd.	10	2 %	2½ %	...	5 — 7	5 — 7	...	...
100,000£	Do. do. 6 % Debs.	100	6 %	6 %	...	105 —109	105 —109	...	...
15,000	Monte Video Teleph. Co., Ord., 1 to 15,000	5	...	...	...	... — ...	... — ...	...	...
28,000	Do. do. 6 % Pref., 1 to 28,000	5	*nil*	4 %	...	1½— 2½	1½— 2½	...	..
484,597	National Teleph., Ltd., 1 to 438,984	5	5 % §	5 % §	5 %	5½— 5⅝	5½— 5⅝	5⅝	5 9/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	15½— 16½	15½— 16½	16½	16¼
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	15 — 16	15 — 16	15⅝	15 1/16
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 90,950	5	5 %	5 %	...	5¾— 6	5¾— 6	6	5 13/16
1,100,000£	Do. 3½ % Deb. Stock Red.	...	3½%	3½%	...	104 —106	104 —106	105¼	104½
48,800	New Teleph., Ltd., 25,901 to 74,700; £4 paid	10	...	...	...	... — ...	... — ...	...	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	...	4½%	1/16 — 1/8	1/16— 1/8	...	...
100,000£	Pacific and European Tel., Ltd 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	105 —108	105 —108	...	...
11,839	Reuter's Ltd.	8	5 %	0 %	...	4 — 5	3½— 4½	3½	...
3,381	Submarine Cables Trust	Cert.	...	...	...	122 —127	123 —128	125	123
58,000	United River Plate Teleph., Ltd.	5	...	...	...	1 — 2	1 — 2	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	85 — 90	85 — 90	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	..	0 %	...	4 — 5	4 — 5	4⅝	...
238,300£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	102 —105	102 —105	102¼	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	1½— 2½	1½— 2½	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	98 —103	98 —103	...	...
64,245	Western and Brazilian Teleg., Ltd.	15	2½%	2½%	3 %	9⅝— 10¼	9⅝— 10¼	10¼	...
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	6¼— 6⅝	6¼— 7	6 1/16	6½
33,129	Do. do. do. Def. Ord. ...	7½	...	...	1 %	3⅝— 4¼	3⅝— 4¼	...	...
171,900£	Do. do. do. 6 % Debs. "A," 1910 ...	100	6 %	6 %	6 %	101 —105	102 —106	...	...
214,800£	Do. 6 % Mort. Debs., series "B," red. Feb. 1910	100	6 %	6 %	6 %	101 —105	102 —106	...	...
88,321	West India and Panama Teleg., Ltd.	10	1/4%	7/8%	1/4%	7/8— 1⅛	7/8— 1⅛	1	...
34,563	Do. do. do. 6 % 1st Pref. ...	10	6 %	6 %	6 %	11 — 11½	11 — 11½	11⅜	...
4,669	Do. do. do. 6 % 2nd Pref. ...	10	6 %	6 %	6 %	9 — 10	9 — 10	9½	...
80,000£	Do. do. 5 % Debs. (1917) No. 1 to 1,000	100	5 %	5 %	5 %	109 —112	109 —112	...	...
$1,211,000	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7 %	115 —120	113 —118	...	...
166,900£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6 %	101 —103	101 —103	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	5 %	4½%	4½%	5½— 5⅝	5½— 5⅝	5 9/16	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	...	5 %	13 — 14	13 — 14	13¼	13 1/16
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	15 — 15½	15½— 15⅝	15½	15½
100,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	133 —136	133 —136	...	...
50,000	†Liverpool Electric Supply, all paid	5	5 %	5 %	5¼%	7⅛— 7⅜	7 1/16— 7 1/16	.	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	2 %	2½%	...	10 — 10½	10 — 10½	10½	10⅛
100,000£	Do. 5% Deb., bonds of £10, £20, £40	...	5 %	5 %	...	... — ...	... — ...	...	...
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	118 —120	118 —120	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	1 %	7½— 7¾	7½— 8	7⅞	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-18,780	5	7½%	4½%	6½%	7½— 8	7½— 8½	8 1/16	7 15/16
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8½— 9	8½— 9½	...	...
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	3½%	4 %	5 %	7½— 8	7½— 8	7 15/16	7⅞

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

esent Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation, May 1st.	Closing Quotation, May 8th.	Business done during week ended May 8th, 1895. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	3	6 % §	6 % §	...	2⅜— 2⅝	2⅜— 2⅝	2 9/16	2 7/16
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 % §	6 % §	...	2¼— 2½	2¼— 2½	2½	2 5/16
125,000/	Do. do. 4½ % Deb.	Stock	4½%	4½%	...	113 —116	113 —116	...	...
630,000/	City and South London Railway	Stock	5%	5%	1¼%	45 — 47	45 — 47	46⅜	45½
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	7 % §	7 % §	...	2½— 3	2½— 3	...	...
50,000/	Do. do. 5 % 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	5 %	5 %	5 %	... — ...	no quotation	...	...
120,000	Electric Construction, Ltd., 1 to 120,000	2	*nil*	*nil*	...	¼— ⅜	⅝— ⅞	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	...	1¼— 1½	1¼— 1½	...	...
100,000	Elmore's French Patent Cop. Deposg., Ltd., 1 to 66,750 ...	2	*nil*	*nil*	...	... — ...	... — ...	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	1 — 1½	1 — 1½	1 1/16	1
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	1½— 1⅝	1½— 1⅝	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	...	½— 1½	½— 1½	...	...
9,600/	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	*nil*	...	6½— 7½	6½— 7½	...	...
6,837	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	5 %	6 %	9½— 10½	9½— 10½	10⅜	10 1/16
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	10 %	21½— 22½	21½— 22½	22½	22
200,000/	Do. do. do. 4½ % Deb., 1896	100	4½%	4½%	4½%	101 —103	101 —103	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	1 %	1½%	8 1/16— 8 3/16	8⅛— 9	...	...
6,295	† Do. do. Pref., £10 paid	10	...	5 %	5 %	14 — 14½	14 — 14½	...	...
	Swan United Electric Light, Ltd.	...	10 % §	7½% §	...	... — ...	... — ...	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	20 %	20 %	39 — 41	39 — 41	41	40½
150,000/	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	106 —109	106 —109	108¾	...
54,000	Waterloo and City Railway, Nos. 1 to 54,000, £2 paid ...	10	...	...	...	2½— 2⅝	2½— 2⅝	2⅝	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7%; 1890—8%.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅞—6¼.
Electric Construction Corporation, 6 % Debentures, 84—87.
Electric and General Investment, shares of £5 (£1 paid), 1½—2
House-to-House Company (£5 paid), 3⅞—4⅛.
Do. do. 7 % Preference, of £5, 7 —7½.
Do. do. 6 % Debentures of £100, 107—109.
Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 7¼—7⅜; 1st Preference Cumulative 6 %, £5 (fully paid), 7—7⅛.
Liverpool Electric Supply, £5 (fully paid), 7¼—7½.
London Electric Supply Corporation, £5 Ordinary, ¼—½.
Queen Anne's Mansions Lighting and Heating Company, 6 % £100 Debentures, 99—101 nominal.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 5⅞—6.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

TESTS OF GLOW LAMPS, AND DESCRIPTION OF THE MEASURING INSTRUMENTS EMPLOYED.*

By Prof. W. E. AYRTON, F.R.S., and E. A. MEDLEY.

(*Continued from page 567.*)

The lamps being tested were arranged in the special stand shown in fig. 7. The circular plate, A, which could be turned on the centre pillar, B, was divided into six compartments by the radial divisions shown, and the nine lamps simultaneously tested were placed in three of these compartments, which were coloured a dead black inside. The whole was covered up with an outer tin case, drawn in broken lines, which was fixed to the uprights, C, D, E, F, and had an opening in front through which any one of the groups of lamps could be seen when turned into position.

When photometric measurements were not being made, the top of the case was left open to let out the heat.

The arrangements for measuring the current and for bringing it to the lamps are sketched in fig. 8. M and N are the main terminals of the lamp-stand, corresponding with M and N in fig. 7. From M the current, after passing through the resistances *e* and *d*, for the two groups run at lower pressures, went through the lamps and reached the terminal N by means of the copper springs *a*, *b*, and *c*.

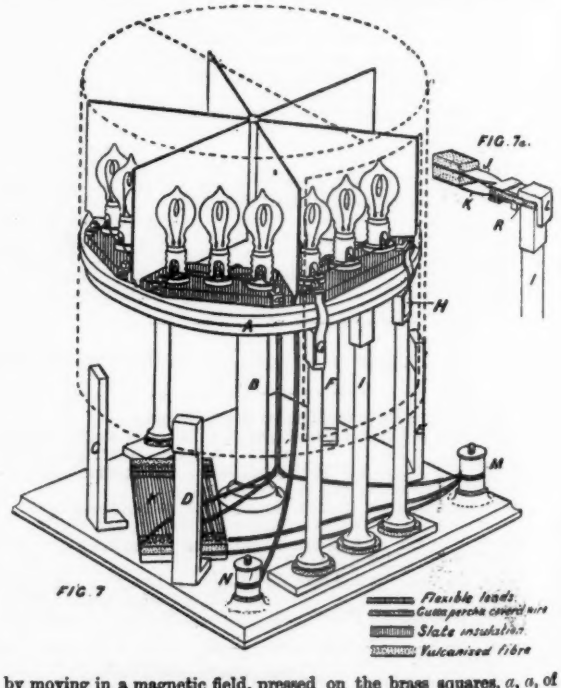
When, however, a group of lamps was turned into position for photometric measurements, its copper springs, *c*, J and K in fig. 7A, were separated by a piece of brass, L, backed with insulation, R in fig. 7A, and so the current of the group was diverted through a thick wide strip of manganin, this strip being shunted with an Ayrton and Mather D'Arsonval galvanometer, A, in series with a resistance, B, as seen in fig. 8.

This combination of galvanometer resistance, B, and manganin strip was calibrated by direct comparison with a Kelvin-balance, and the resistance, B, was so adjusted, that one ampère produced a deflection of 500 divisions, each of about a millimetre in length. Variations of current during the experiments could be read to $\frac{1}{5000}$ of an ampère if required, and the current was known accurately in Board of Trade ampères to $\frac{1}{1000}$ of an ampère.

The results of frequent comparisons between an ampère as read off the direct-reading transparent scale and an ampère as measured with the Kelvin balance, which was also screwed down permanently in position, never showed a difference as large as 1 part in 1,500 between September, 1893, and August, 1894.

* Paper read before the Physical Society, January 11th and 25th, 1895.

The positive and negative terminals of each group of lamps were connected respectively with two squares of brass, *a*, *a* (fig. 7), let into the slate bed on which the group was mounted. Two brass springs, G, H, permanently connected with an Ayrton and Mather reflecting electrostatic voltmeter, the motion of the needle of which was damped



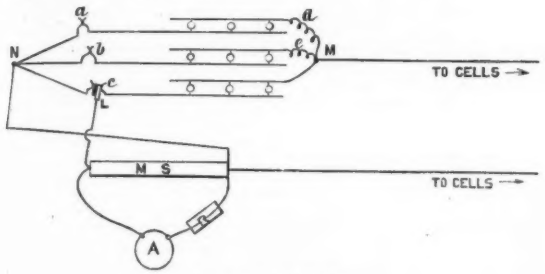
by moving in a magnetic field, pressed on the brass squares, *a*, *a*, of whichever group of lamps was brought to the front of the stand.

The zero of the voltmeter was so arranged that the transparent

scale, which was direct-reading, was nearly uniformly divided from 50 to 120 volts, each division of about 1·5 millimetre representing 0·2 volt, so that it was easy to read the deflection to within 2 parts in 10,000.

The electrostatic voltmeter was frequently calibrated, and the maximum change in sensibility between July, 1893, and August, 1894, did not exceed 0·2 per cent. This change, although small, is fully accounted for by the variation in the zero, since the instrument did not possess the delicate zero adjustment of the later specimens of this type of voltmeter.

The standard of light we used was a 2 candle-power Methven screen fed with *pentaned* gas, and against this a 10 candle-power Bernstein glow lamp was standardised to give five candles, the Bernstein lamp being employed for the actual comparison with the Edison-Swan lamps.



M, , manganin strip.

FIG. 8.

One of the objects of employing this Bernstein lamp was to test whether or no a convenient and trustworthy standard of light could be obtained by using a low voltage lamp with its filament at a comparatively low temperature. From this point of view, however, the results were not very satisfactory, as at the end of some 60 hours of life the lamp had blackened heavily. This secondary standard was of course tested very frequently—as a rule, every time it was used.

For the last few hundred hours of our tests an 8 C.P. 100-volt Edison-Swan lamp running at five candles was used as an intermediate standard of light, and after the first few hours it gave very fair results, the current required to produce exactly five candles dropping in almost a straight line from 0·3893 to 0·3867 ampère in 200 hours. It is probable, for reasons which will be shortly apparent, that an even better result would have been obtained if the lamp had been run for some 50 hours at its normal brilliancy before it was used as a standard of light.

For measuring the light a Lummer-Brodham photometer was used, and proved itself a very convenient instrument. The lamp-stand was fixed at the end of a three-meter photometer bench, the actual distance between the standard and the Edison-Swan lamps being 319·5 centims.

Some difficulty was found at first in measuring the candle-power owing to the very considerable difference in colour between the lights being compared. This difficulty was considerably reduced by fixing the Bernstein lamp to the spring frame shown in fig. 9, where A is the lamp, S, S, are steel springs, and W, W, are leaden weights.

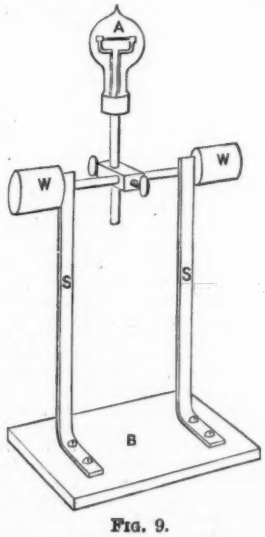


FIG. 9.

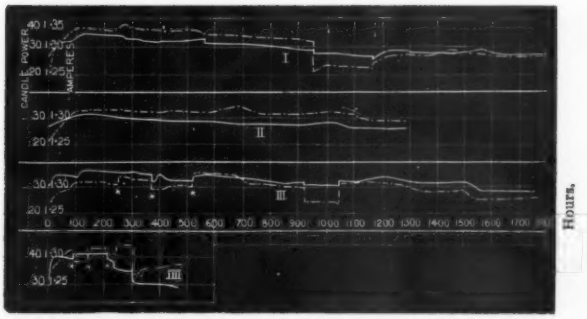
When measurements of the candle-power were being taken, the Bernstein lamp was set gently swinging backwards and forwards in the direction of the bench, and the effect thus easily produced was found to be an improvement on that usually obtained by moving the photometer first a little on one side, and then a little on the other, of the neutral point. After some practice, the use of this contrivance enabled us to make measurements of the candle-power which did not differ from each other by more than 0·3 per cent.

The first point noticed after starting the tests was that candle-power, current, and candles per watt all *rose* as the lives of the lamps increased; and as we were not prepared, from the published accounts of experiments previously made on glow lamps to expect any such result, we thought it might be due to some error in our measurements. We therefore made a number of tests to satisfy ourselves that this was not the case.

A current nearly twice as large as the maximum required to be measured was sent through the manganin strip for several hours, but the deflection of the D'Arsonval galvanometer for a given current was not altered, so that the effect was certainly not due to the heating of the strip or galvanometer coil.

As the voltmeter was connected with the terminals of the lamp sockets and not with the terminals of the lamps themselves, we tested whether any resistance was introduced by the sockets, or whether any alteration occurred when they got warm after the lamps had been burning for some hours. An old lamp was taken and wires soldered to its terminals, and also to the terminals of the socket into which it was screwed, and, by measuring as nearly simultaneously as possible, the pressures on the lamp and on the socket terminals under various conditions as to heat and position of lamp, we proved that the resistance of the socket and contacts was never perceptible.

There seemed, therefore, no reason to doubt the results already obtained; but as the accuracy with which the candle-power could be measured had increased with practice and with the introduction of the swinging frame, we decided, after 110 hours of testing, to start again with new lamps.



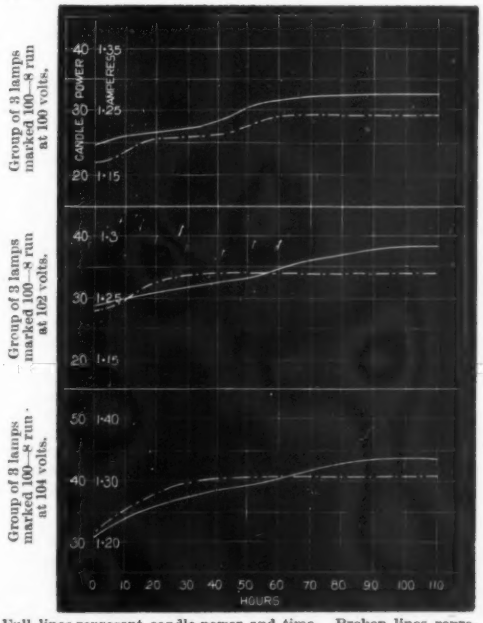
Full lines represent C.P. and time. Broken lines represent ampères and time. The breaks in the curves connected by perpendicular lines show where a lamp has broken and a new one been put in.

* The six lamps put in at these places had already been run for 110 hours at 102 and 104 volts.

I. Group run at 100 volts; II. Group run at 101 volts; III. Group run at 102 volts; IIII. Group run at 104 volts.

FIG. 10.—LIFE TESTS ON EDISON-SWAN 8 C.P. 100-VOLT LAMPS RUN AT VARIOUS VOLTAGES.

The results obtained in these preliminary tests are shown in fig. 10A, the curves in fig. 10 being those obtained from the lamps subsequently tested.


Group of 3 lamps marked 100—8 run at 100 volts.
Group of 3 lamps marked 100—8 run at 102 volts.
Group of 3 lamps marked 100—8 run at 104 volts.
CANDLE POWER
AMPERES
HOURS

Full lines represent candle-power and time. Broken lines represent ampères and time.

FIG. 10A.—PRELIMINARY TESTS ON EDISON-SWAN 8 C.P. 100-VOLT LAMPS RUN AT VARIOUS VOLTAGES.

These curves show the variation of light and current with time for four groups of lamps, between the terminals of which perfectly constant P.Ds. of 100, 101, 102, and 104 volts were maintained respectively, the full lines representing candle-power and the dotted lines current. The breaks in the curves connected by vertical lines

indicate the times at which a lamp broke and was replaced by a new one, so that each group always consisted of three lamps.

All these curves show that the light given out by these Edison-Swan lamps was *greater* after they had been glowing for some time than it was when the lamps were new; also that even just before the filament of one lamp in a group broke, the total light given out by the group of three was greater than when the lamps were new. This is a totally different result from that obtained in earlier tests, as illustrated in figs. 1, 2, 3, and 4, which showed that a considerable deterioration in candle-power always took place after lamps had been running for some time. Further, while the globes of earlier lamps were always much blackened, even after a run of a few hundred hours, and so became comparatively useless long before the filament broke, the Edison-Swan lamps which we have been testing showed hardly any blackening, even when the filaments lasted for over 1,300 hours.

The highness of the average candle-power of Edison-Swan lamps marked 100—8 after they have been run for some time at 100 volts, is corroborated by the figures in the following table, which gives the results of the measurements of the candle-power and the watts per candle of eleven 8-candle 100-volt lamps which had been run from the mains of the Notting Hill Electric Lighting Company. As these lamps had been used in different rooms of a dwelling house, it was impossible to say for how many hours they had been run, but the time probably varied from about 200 to 600 hours, and at any rate none of them were new.

The measurements were taken at 100 volts, and Harcourt's pentane burner was the standard of light used.

Candle-power.	Watts per candle.	Candle-power.	Watts per candle.
10·5	4·10	10·5	4·04
11·9	3·77	8·4	4·10
7·37	5·41	9·73	4·23
7·65	4·51	10·05	4·19
12·68	3·43	9·78	4·31
11·25	3·92		

In these lamps, as in the others we tested, the blackening of the bulbs was very slight indeed. Since the above measurements were made, the two lamps whose candle-powers were 11·9 and 11·25 have broken after about another hunded hours of life without, as far as could be judged, any diminution in their light, or any increase in the blackening of their bulbs.

Moreover, although the rise of candle-power seen in figs. 10 and 10*a* was always accompanied with a rise in current, yet, as the rise in candle-power was proportionally much greater than the rise in current for the lamps we tested, as will be seen from figs. 10 and 10*a*, where one division represents 50 per cent. change in the light, but only 4 per cent. change in the current, the consumption of power per candle was actually *less* after the lamp had run for 50 hours than it was at the beginning, and the power per candle did not rise seriously during the whole life of a lamp.

Examining the results for the group run at 100 volts, we see that in the first 124 hours the candle-power rose from 26·3 to 35, or by 33·1 per cent., the current in the same time rising from 1·261 to 1·335 ampères, or by 5·87 per cent., so that during these first hours the watts per candle dropped from 4·79 to 3·82.

During the 1,820 hours of running, three lamps broke in this group, their lives being 572, 957 and 1,167 hours; the three still unbroken at the end of the tests had been run for 1,248, 863 and 653 hours respectively.

Over the first 500 hours the average consumption of energy with the lamps run at 100 volts was at the rate of 4·0 watts per candle, over the second 500 hours 4·36 watts per candle, over the third 500 hours 4·55 watts per candle, and over the whole run the average efficiency was 0·23 candle per watt, corresponding with 4·35 watts per candle.

The candle-power of the three lamps run at 101 volts rose in the first 150 hours from 26·5 to 30·6, that is by 15·5 per cent., the current rose from 1·27 to 1·33 ampère, or by 4·72 per cent., the watts per candle in the same time falling from 4·80 to 4·32. The average watts per candle over the whole run of 1,340 hours of this group were 4·68, corresponding with an efficiency of 0·215 candle per watt.

In the group at 102 volts, which was run for 1,820 hours, six lamps broke, their lives being 242, 372, 516, 570, 516 and 786 hours respectively in the order of breaking; the three lamps unbroken at the end of the tests had run for 1,148, 898 and 772 hours respectively.

The initial rise in candle-power in this group at 102 volts was from 30·6 to 35, or a rise in 120 hours of 14·4 per cent, the current in the same time rose from 1·26 to 1·31 ampères, or by 3·97 per cent., so that the watts per candle diminished from 4·22 to 3·82.

The average consumption of energy during the first 500 hours was at the rate of 3·9 watts per candle, during the second 500 hours 4·06 watts per candle, during the third 500 hours 4·2 watts per candle, and over the whole run the average was 4·12 watts per candle, corresponding with an efficiency of 0·243 candle per watt.

Turning to the group run at 104 volts, the curves show that the breakages were very frequent. Altogether five lamps broke, their lives being 94, 175, 210, 242 and 254 hours; the three lamps left unbroken at the end of the test had been run for 165, 222 and 364 hours.

The initial rise in candle-power was from 33·8 to 50·5 candles, that is by 19·8 per cent.; and the current rose from 1·264 to 1·307 ampères, or by 3·4 per cent.

Over the whole run the average watts per candle, for the lamps run at 104 volts, were 3·6, corresponding with an efficiency of 0·278 candle per watt.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

A Magnetic Tester for Measuring Hysteresis in Sheet Iron. By Prof. Ewing, F.R.S., member. Read April 25th, 1895.

Makers of transformers are now generally alive to the paramount importance, from the point of view of all-day efficiency, of using iron in which the hysteresis losses are small. The need, however, is felt of some simple means by which this quality can be readily determined. Tests made by the ballistic and other methods have shown that different samples of iron may exhibit extraordinarily wide differences in regard to hysteresis. The author has found, for example, in the course of his own tests of iron supplied for transformers, a range of nearly three to one in the hysteresis of good and bad samples. It is unnecessary to point out how much the all-day efficiency of a transformer working under ordinary conditions will be affected if the sheet iron used in its construction has three times as much hysteresis as it need have. Again, experience shows that even in one batch of plates, of the same rolling, so much difference is apt to exist between one plate and another as to make the testing of a single sample furnish a poor guide to the average quality of the batch. Even in a single plate samples cut from different parts show marked differences in hysteresis. The author has noticed as much as 15 per cent. variation in samples taken from the four corners of a plate not quite 2 feet square, the material of which was of very excellent quality. It is well known that different analyses of the nearly pure iron of which such plates are rolled exhibt corresponding variations. The impurities appear to be unequally distributed; and, further, it is not unlikely that the irregularities which are found in the magnetic quality depend in part on slight differences in the treatment as regards annealing. Whatever their cause, there can be no doubt that they exist, and their existence makes the result of a single test often somewhat fallacious. What is wanted is a sufficiently large number of tests, in any one batch of iron, to allow a fair average to be estimated for the quality of the batch.

To make this possible a simple and expeditious method of testing is imperative. The ballistic method, although unimpeachable on the score of accuracy, is anything but expeditious, and can scarcely be called simple. The value of the hysteresis is arrived at by first observing the relation of the induction, B, to the magnetising force, H, for a considerable number of points in each of a series of cyclic processes of magnetisation, then drawing the B—H curve for each of these cycles and measuring the enclosed area. The operation requires some skill and experience, and a good deal of patience. The same criticism applies to other methods of finding the hysteresis by first finding the relation of magnetism to magnetising force (as, for instance, by the permeameter or by the author's magnetic curve tracer). It must be borne in mind that in the testing of transformer iron the permeability is a quite secondary matter. What is of primary importance is the hysteresis, and high permeability is not necessarily or invariably found associated with small hysteresis. In the testing of sheet iron by the ballistic method the finding of the relation of B to H is a step in the process; it is not the object of the test.

These considerations have led the author to devise an apparatus which measures the hysteresis directly, by a single operation, and in a manner sufficiently simple to allow the test to be applied to numerous specimens without much expenditure of time, trouble, or iron. The basis of the instrument is the mechanical measurement of the work done in causing reversals of magnetism to take place in the iron under examination. Such measurements have been made before as a laboratory experiment and under special conditions. Thus, Mr. L. R. Wilberforce and the author, two or three years ago, endeavoured to determine the hysteresis of a cylinder of iron when rotated in a strong magnetic field, by measuring the couple required to keep it slowly turning. And a method of the same general character has beem employed with complete success by Mr. F. G. Baily to investigate the disappearance of hysteresis which takes place in such a cylinder when the field is made sufficiently strong—a matter of great interest in connection with the molecular theory of magnetism. In the machine now brought forward as a practical tester for workshop use the same mechanical principle is involved. The process of reversal, however, resembles that which occurs in a transformer rather than in a dynamo; the induction is caused to have practically the same value in all samples, and that a value appropriate from the transformer point of view; the sample is cut in a very simple form, and is arranged to be readily inserted and removed. The magnetism is reversed by turning a handle, and the result is given by the position of a pointer on a scale.

Fig. 1 is from a photograph of the instrument now exhibited, the form of which has been reached after a good deal of experiment. The iron to be tested is cut or stamped in the form of strips, which are 3 inches long and $\frac{8}{10}$ths of an inch wide in this instance. The number of these pieces that is taken to compose the sample depends on the thickness of the sheet; six or seven pieces will in general be sufficient for the usual gauges of transformer iron, and a smaller number if the material tested is the thicker sheet used in dynamo armatures. The bundle of pieces forming the sample is placed in a carrier, *a*, and is covered with a vulcanite washer and secured by two clamps, *b*, *b*. The carrier is made to rotate by means of the friction pulley, *c*, and driving wheel, *d*. This causes the sample to revolve between the poles of the permanent magnet, *e*, with the effect that its magnetism is periodically reversed. The work done in reversing the magnetism, in consequence of hysteresis, causes a mechanical moment to be exerted by the revolving sample upon the magnet; and the magnet, being supported on a knife-edge at *f*, in line with the axis of the carrier, tends to follow the sample and is deflected through an angle which serves to measure the work expended. Since

a definite amount of work is done per reversal, whatever the frequency (so long as that is not so high as to make a sensible addition to the work by inducing currents), the deflection of the field-magnet is independent of the speed at which the carrier revolves, and no special care has to be taken to turn the handle at a uniform rate. If the rate is very slow the magnet will show each individual impulse which it receives as the ends of the sample pass its poles, but when the speed is sufficiently raised these impulses blend into a steady deflection; and the speed may be further augmented to the extent of doubling it, or more, without making the deflection change. It is only at higher speeds still that the effects of induced currents become apparent. The deflection is observed by means of a pointer and scale above the magnet. The swinging of the magnet is checked by means of a dash-pot below, consisting of a vane, or spade, moving in a box filled with oil. The stability is adjusted to give any required degree of sensitiveness by means of the weight, *g*, which travels as a nut upon a screw fixed to the magnet, and serves to raise or lower the centre of gravity of the oscillating system. The magnet swings about a knife-edge working in an agate trough, and a lifting arrangement like that of a balance is provided, operated by the handle, *h*, to save the knife-edge from unnecessary wear or injury. The pointer is set to zero in the middle of the scale by means of a nut which runs on a screw projecting sideways from the middle of the magnet, and a more delicate adjustment of the zero may be effected by means of the levelling screw, *i*. In operating, the observer inserts the sample and secures it by the clamps, then begins to turn the handle and lets the magnet down on its knife-edge. After reading the deflection of the pointer to one side he reverses the direction of rotation, reads the deflection to the other side, and takes the sum of the two readings as the total deflection. The deflection is proportional, or very approximately proportional, to the hysteresis of the iron, even when samples widely different in quality are compared.

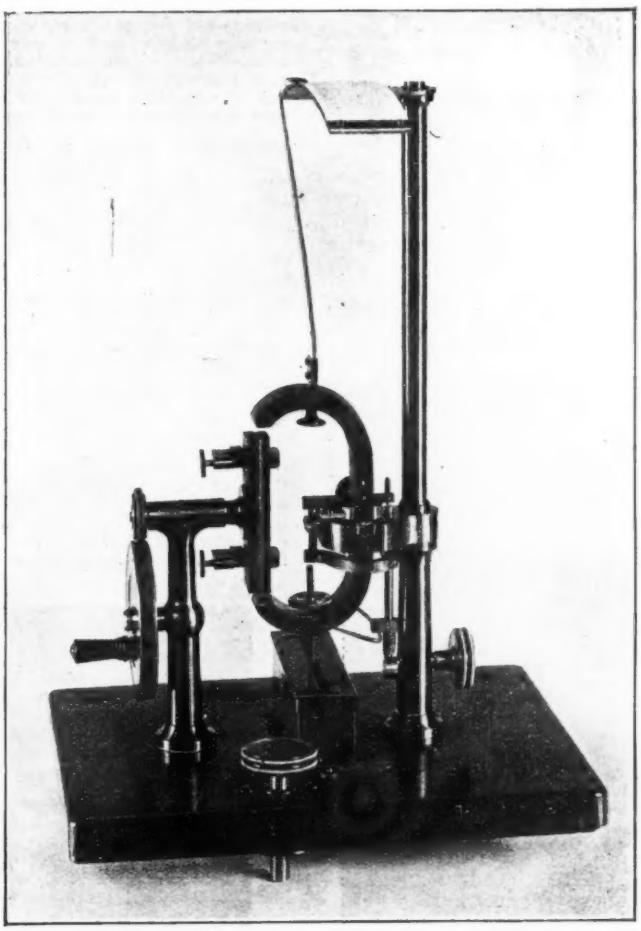


Fig. 1.

To secure that this shall be so, a considerable air space is left between the magnet poles and the ends of the sample, with the result that such variations of permeability as are liable to be met with in different samples are almost without influence upon the total induction through the iron. The author has examined the induction by means of a search coil wound round the sample, and has found it to be practically the same in the best and worst specimens of transformer iron. The dimensions and strength of the field-magnet are so proportioned, with reference to the section of the sample and to the extent of the air-gaps, as to make the induction have a value fairly representative of transformer work. In the instrument shown the induction is about 4,000 C.G.S. units with the normal size of test sample. By increasing or reducing the area of section of the sample, the intensity of the induction is reduced or increased. Within reasonable limits, however, any value of this intensity may be adopted in testing, for it is known from the results of ordinary ballistic tests that curves drawn to show the relation of the hysteresis loss to B preserve their relative positions through a wide range of values of B. In other words, the relative amounts of hysteresis in different samples do not change, or scarcely change, when the iron is more strongly or less strongly magnetised. This, of course, follows from the fact that a formula of the type originally suggested by Mr. Steinmetz,

$$\text{Hysteresis loss} = c\,B^n,$$

is practically applicable, c and n being constants, within limits which are more than sufficiently wide to include the inductions used in transformers.

In cutting the pieces which are to make up the sample care has to be taken to make the length always the same, otherwise the air gaps, and consequently the induction, will vary irregularly. The carrier is formed so that it serves on a length gauge; and to facilitate the preparation of the samples a supplementary gauge is furnished, in the form of a clamp of hardened steel, in which the strips are readily filed to the exact length after being cut a trifle too long. The width of the pieces requires no particular care.

Number of strips in sample.	Scale readings of magnetic tester.	
	(Specimen A.)	(Specimen B.)
11	72	118
10	71	117½
9	70	117
8	69½	116½
7	69	116½
6	69	117
5	69	120
4	71	124
3	75	132
2	85	142
1	69	130

The author was under the expectation that it would be necessary, in making an accurate comparison of quality between different specimens, to give the sample the same weight in each case, in order to make it have the same cross section. He finds, however, that no nice adjustment of the weight is required, provided advantage is taken of a property which will be most easily explained by citing an experiment made with the tester.

The experiment in question shows the effect of varying the section of the iron by varying the number of strips which make up the sample. Eleven strips of thin transformer iron were taken, each 3 inches long by $\frac{5}{8}$ths of an inch wide, cut from the same plate. These were all used to form the sample in the first instance; then one was removed, and the remaining 10 were tested then 9, and so on, until finally the sample under test consisted of a single trip. The scale readings for this, and also for another exactly similar experiment, which was made with a different specimen of transformer iron, of a poorer quality than the first, are given in the table. The two specimens are distinguished as A and B.

These results are also shown in the curves of fig. 2. It will be seen that both curves have the same general character, and that the scale readings of the tester pass a very flat minimum when about seven pieces form the sample. Whether six, seven, or eight pieces be used, there is no material difference in the readings. Precisely similar results are given by other specimens. Hence, if a weight is chosen equal to that of seven pieces of this material as a general standard, it will suffice, in preparing other samples for test, to select that number of strips which will give a weight approximating even roughly to the standard weight. The nearest whole number of strips will do, and it is not necessary to cut a narrow or wide strip to make up the exact weight.

When only two or three strips of this thin iron are taken the work expended in reversing the magnetism of the bundle is increased. The total induction through the sample is somewhat diminished; but the intensity is increased, and this more than compensates for the smaller volume of iron that is being operated on. It is only when the sample is reduced to a single piece that the saturation of the iron prevents B from increasing sufficiently to continue this effect, and there is then a sharp fall in the curve.

These considerations have led to the use of samples the aggregate thickness of which is equal to that of six or seven thin transformer plates. In testing armature plates the same weight is approximated to by taking a smaller number of pieces. It is scarcely necessary to add that solid pieces, or bundles of wire, may be tested as well as sheet iron.

Calibration.—An extensive series of experiments has been made in

order to determine to what degree of accuracy the readings of this magnetic tester correspond to the hysteresis losses as found by ballistic tests for various samples of iron. For this purpose it was necessary to test each identical sample in as nearly as might be the same state, first ballistically, and then in the new tester. In view of the variations which are observed between one part of a plate and

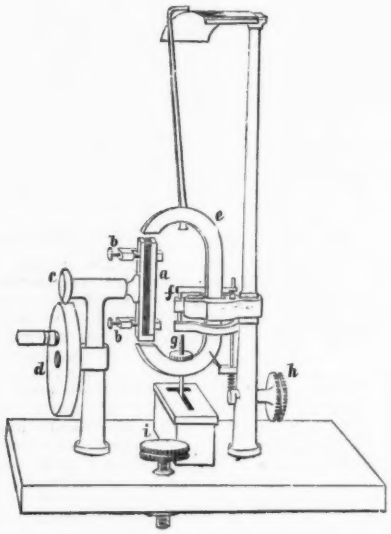


FIG. 1A.

another, the anthor did not feel that it would be satisfactory to use separate pieces for the ballistic observations, and for the observations to be made with the tester. After some consideration he adopted the following two plans:—

In the first place, the ballistic tests were made on rings, each consisting of a long strip cut to the width subsequently wanted in the magnetic tester, namely, five-eighths of an inch. This was bent into a ring, the ends just overlapping. After bending, the ring was annealed in a gas flame to get rid of the hardness produced by the bending. This is a most essential step, for in good iron the process of coiling into a ring, even of large diameter, hardens the metal very perceptibly and increases the hysteresis. Then the ring was tested

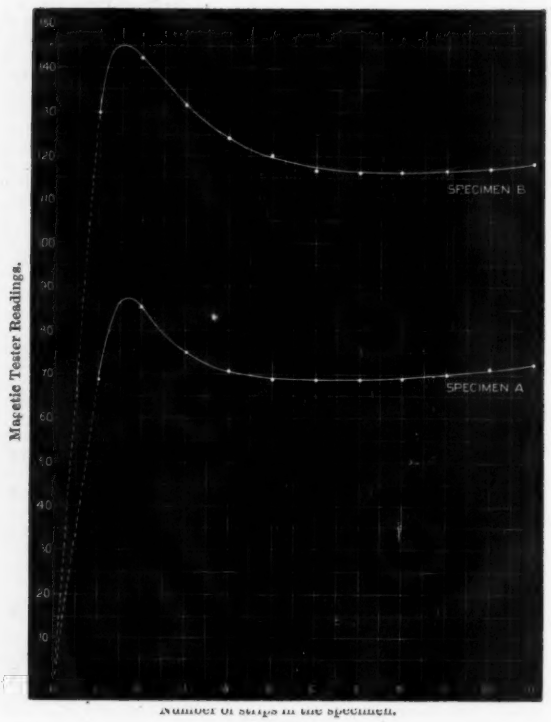


FIG. 2.

ballistically, a sufficient number of cycles being taken to allow a curve to be drawn showing the relation of the hysteresis loss, or $\int H\,dI$, to B, from B = 2,000 to B = 8,000 or so. The same thing was done with each ring. Then the rings were uncoiled and cut up into 3-inch lengths for the tester, and the pieces were straightened and annealed to get rid of the hardness due to this straining. The whole number of pieces into which each ring had been cut were then dealt out into packs of six (or five, or seven, according to the thickness of the material), and these packs were shuffled until repeated trials in the tester showed that every pack gave nearly the same scale reading. The mean scale reading for the several packs obtained from each ring was then taken as a mean applicable to that ring. Here it was assumed that the first and second annealings might be held to bring the material into the same physical state.

To guard against any uncertainty on this point, four additional trials were made, using a different procedure. Long strips were again cut, but each of them was tested ballistically in its original straight form in a solenoid with open ends, the induction coil being wound over the central region only. Each strip was 36 inches long and five-eighths of an inch wide, and a single strip was used in each test. The general effect of the free ends is to shear over the B.H. diagram, but not to alter the enclosed area. Enough areas were measured to determine, as before, the curve of $\int H\,dI$ and B for each strip. The strips were then cut up into pieces for the tester, which were treated as in the former case. In this procedure there was no annealing.

By these two means seven standard samples in all were produced, of quality ranging from exceptionally good to exceptionally bad. The magnetic tester readings for these were taken, using approximately equal weights to form the sample in each case. In the following table the tester readings are given alongside of the value of the hysteresis loss ($\int H\,dI$) as determined ballistically for an induction, B, of 4,000 units for each of the seven specimens. Numbers I., II., and III. were those tested ballistically in the ring form; the others were tested in the form of straight strips.

Comparison of Magnetic Tester Readings with the Hysteresis Loss determined by Ballistic Tests.

No. of specimen.	Magnetic tester scale readings.	Hysteresis loss by ballistic tests. Ergs per c.cm.
I.	60	640
II.	81	890
III.	124½	1,420
IV.	70	750
V.	125½	1,430
VI.	136	1,580
VII.	184	2,120

The same results are shown graphically in fig. 3. It will be seen that they accord well with one another, and that the scale reading of the magnetic tester is nearly proportional to the hysteresis loss. A straight line drawn from the origin among the observed points lies sufficiently near all of them to allow the assumption to be made, so far as workshop testing is concerned, that the deflection in the tester,

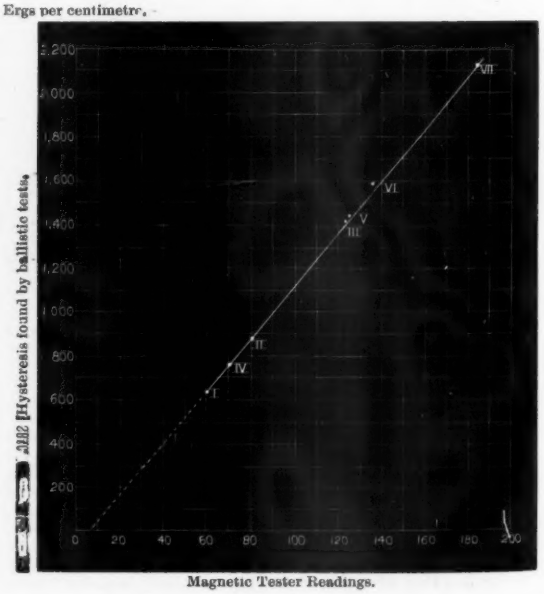


FIG. 3.

when multiplied by a factor depending on the sensitiveness of the instrument, is a practical measure of the hysteresis.

More exactly, however, the locus of the points is seen to be a straight line passing not quite through the origin. This may be partly due to the fact that the induction produced in the tester is not absolutely so high in the bad as in the good iron. In all probability, however, it is mainly due to this—that as the sample revolves some small amount of work is done in periodically changing the distribution of magnetism in the field-magnet itself, in addition to the work that is done in reversing the magnetism of the sample. Any

work expended within the field-magnet would contribute to the deflection, and would exist even if the sample (while retaining its permeability) were entirely destitute of hysteresis. Hence the line may be expected to pass a little to the right of the origin, as it is actually found to do.

It is intended to furnish with each instrument two standard samples of iron, along with a table stating their hysteresis as found by reference to ballistic experiments (in ergs per cubic centimetre, and also in watts per lb., at an assigned frequency). In proceeding to test other samples the operator will first note the deflection given by each of his standard pieces, and then, by simple proportion, or by aid of a diagram, he may go on to interpret in absolute measure the deflection observed with any specimen. This will make his results independent of any loss of strength on the part of the field-magnet, or of any changes he may find it convenient to make in the sensibility of the instrument.

The hysteresis of the standard samples is stated for B = 4,000. To find the hysteresis for any other induction it is only necessary to use the following table of factors, which has been deduced by the author as a general mean from ballistic tests of many samples:—

Induction B.	Relative amount of hysteresis.
2,000	0·33
2,500	0·47
3,000	0·63
4,000	1·00
5,000	1·41
6,000	1·89
7,000	2·41
8,000	3·00

Other forms of the instrument can be constructed by making the field revolve while the sample is pivoted, so that the sample deflects; by placing the axis vertical instead of horizontal, with a control furnished by a spring or by bifilar suspension; by using a weighted arm or a torsion head to measure the deflecting couple, instead of observing the deflection by a pointer on a scale; and so forth. But the author believes that the form now exhibited will be found both accurate and handy in general use.

He hopes it may contribute indirectly to the betterment of the iron used for magnetic purposes, by making it easy for a purchaser of iron or a purchaser of transformers to specify a maximum of hysteresis, and to see that he gets what he specifies. A notable improvement in the quality of sheet iron in this respect has been going on during the last few years, and it is now practicable to get iron which a short time ago would have been pronounced impossibly good. But it would be easy to quote tests showing that some iron of relatively very poor quality still finds its way into armature and transformer cores. The author's aim has been to put into the hands of those who are practically concerned with magnetic hysteresis, whether as makers of plates, builders of transformers, or engineers of alternate current supply stations, an apparatus in which testing is reduced to its simplest terms, where each test consumes no more than a few square inches of the sheet, where the preparation and testing of the sample take only a few minutes of time, and the operation consists in turning a handle and reading how good or bad the iron is from the position of a pointer on a scale.

Physical Society.

Ordinary Meeting, April 26th, 1895.

Mr. Walter Baily, Vice-President in the Chair.

Prof. S. P. Thompson read a note on A Neglected Experiment of Ampere.

Ampère in 1822 made an experiment which if it had been properly followed up must have led to the discovery of the induction of electric currents nearly ten years before the publication of Faraday's results. While attempting to discover the presence of an electric current in a conductor placed in the neighbourhood of another conductor in which an electric current was flowing, Ampère made the following experiment:—A coil of insulated copper strip was fixed with its plane vertical, and a copper ring was suspended by a fine metal wire so as to be concentric with the coil, and to be in the same plane. A bar magnet was so placed that if an electric current was induced in the suspended ring, a deflection would be produced. No such deflection, however, was observed.

In 1822, in conjunction with de la Rive, Ampère repeated this experiment, using in place of the bar magnet a powerful horse-shoe magnet. He describes the result in the following words:—"The closed circuit under the influence of the current in the coil, but without any connection with this latter, was attracted and repelled alternately by the magnet, and this experiment would, consequently, leave no doubt as to the production of currents of electricity by induction if one had not suspected the presence of a small quantity of iron in the copper of which the ring was formed." This closing remark shows that they were looking for a permanent deflection. When, however, Faraday's results were published in 1831, Ampère after again describing the experiment made in 1822 by himself and de la Rive, says:—"As soon as we connected a battery to the terminals of the conductor the ring was attracted or repelled by the magnet according to the pole that was within the ring, which showed the existence of an electric current produced by the influence of the current in the conducting wire."

Verdet when describing the above experiment falls into a curious error. He says the apparatus consisted of a ring of fine copper wire suspended by a silk thread in front of the pole of an electro-magnet in such a way that the plane of the ring was parallel to the plane of the turns of wire on the electro-magnet. On making the current the ring is said to have been repelled, but this deviation did not persist, and on breaking the current the ring was attracted, also only momentarily.

Mr. Blakesley did not feel quite confident that in Verdet's form of the experiment there would ever be attraction. He also pointed out that with an alternating current the disc would tend to set itself parallel to the lines of force of the electro-magnet. With reference to repulsion by alternating currents in one of Elihu Thomson's experiments where a sphere is supported over an alternating pole, a screen being placed so as to partly shield this sphere, there is generally a mis-statement as to the direction in which the sphere rotates. It rotates in such a direction that the part of its surface next the magnet moves towards the edge of the screen.

Dr. Burton said that from the fact that when the current in the electro-magnet in Verdet's experiment is broken, the induced current in the ring is in the same direction as the current in the magnet and the ring will be attracted.

Mr. Boys confirmed Dr. Burton's statement. He recommended setting the ring at an angle of 45° to the lines of force under which circumstances a rotation would be obtained. A distinction must, he pointed out, be drawn between such an experiment as that of Verdet and those of Elihu Thomson. The repulsions observed in these latter were only due to the "lag" in the induced currents caused by self-induction. The best materials to use for all such experiments were magnesium and aluminium, since for a given mass these had the highest conductivity.

Mr. W. G. Rhodes read a paper entitled, A Theory of the Synchronous Motor.

The object of this paper is to give as simple a treatment as possible of the mathematical part of the subject, and to give theoretical proofs of some experimental facts. Starting from the energy equation

$$p + c^2 R = c E \cos \psi,$$

where p is the output of the motor, R the resistance of the armature, c the current through the armature, E the E.M.F. applied to the motor terminals, and ψ the phase difference between c and E; the cases of maximum output, zero output, minimum current at zero power, and maximum phase difference between c and E are considered. These results are, for the most part, obtained directly from the energy equation. The latter part of the paper is devoted to a discussion of the phase relationships between the current and the E.M.Fs. in a plant consisting of a generator and motor, and to the variations in the armature reactions in both generator and motor. A theoretical proof is given of the fact, observed by Prof. Silvanus Thompson and others, that an over excited synchronous motor acts as a condenser and tends to make the current lead before the generator's E.M.F.

Prof. S. P. Thompson said that the mathematical part of the paper was much simpler than that in previous investigations on this subject, and the method of arriving at the results by rejecting imaginary roots of the equations was particularly neat and instructive. The part of the paper relating to armature reactions and phase relationships was quite new. Two results deserved special attention, first that the maximum current at zero power was the same as if the circuit was non-inductive. Second, that the maximum current at zero power was double the current corresponding to maximum output.

Mr. Blakesley said that the paper did not consider the stability of the system and he thought some of the results corresponded to regions of unstability.

NEW PATENTS—1895.

7,962. "An improved insulating compound." R. V. Houssart. Dated April 22nd.

7,966. "Portable electric apparatus." W. E. Dow. Dated April 22nd.

7,989. "Improvements in electrically-driven wool-shearing or hair-clipping machines." H. W. C. Cox and G. Bowmar. Dated April 22nd.

7,990. "Improvements in telegraphy and apparatus therefor." F. H. W. Higgins. Dated April 22nd.

8,011. "Improvements in the electrodes or plates of electric storage batteries." G. Hubener. Dated April 23rd. (*Complete.*)

8,026. "Improvements in electric railway systems." J. M. Faulkner. Dated April 23rd. (*Complete.*)

8,037. "Improvements relating to electric telegraphs." A. Muirhead. Dated April 23rd.

8,049. "Improvements in or relating to electric alarm clocks." W. P. Thompson. (Communicated by H. W. Knapp and L. E. Gerrety, United States.) Dated April 23rd. (*Complete.*)

8,072. "Improvements in or relating to phonographs." E. Wurl and A. Novotny. Dated April 23rd.

8,081. "Improvements in the active material for secondary and primary batteries." A. Schanschieff. Dated April 23rd.

8,135. "An improved electric light cask searcher and probe." F. Hughes. Dated April 24th.

8,139. "Improvements in lenses for search-light projectors." E. J. Paterson and C. W. Hill. Dated April 24th.

8,147. "Combined trolley and accumulator system for driving electric cars." T. Nees. Dated April 24th. (*Complete.*)

8,161. "Improvements in electric igniting apparatus suitable for lighting tobacco pipes and cigars." F. W. Schindler. Dated April 24th.

8,167. "System of electro-calorigen rheostatic chain." A. Labbe and A. Coussinet, jun. Dated April 25th. (*Complete.*)

8,172. "Belting for machine guns, dynamo, engine, and other purposes." R. D. Bailey. Dated April 25th.

8,186. "Improvements in electric locks." A. Harvey. (Communicated by S. Bash, South America.) Dated April 25th.

8,188. "Improvements in ceiling roses and lamp holders for electric lighting." J. A. Hirst. Dated April 25th.

8,195. "Improvements in cycle, electric, house, table, and other bells and gongs." O. Hanks. Dated April 25th.

8,210. "A method of and means for increasing the directive force of magnetic needles." J. S. Gisborne. Dated April 25th.

8,222. "Improvements in telephonic systems and apparatus." J. E. Kingsbury. (Communicated by The Western Electric Company, United States.) Dated April 25th.

8,226. "Improvements in and relating to electric batteries." J. von der Poppenburg. Dated April 25th. (*Complete.*)

8,253 "Electrical appliance to give signalmen control over drivers during foggy weather." T. Cooper. Dated April 26th.

8,306. "Improvements in or connected with electric batteries." C. P. Shrewsbury, F. L. Marshall, J. Cooper, and J. L. Dobell. Dated April 26th.

8,373. "Improvements in conductors for coupling cells of voltaic batteries." W. S. Rawson. Dated April 27th.

8,385. "An improved wire gauze brush for dynamos and motors." A B. Soar and E. W. Collier. Dated April 27th.

8,392. "An improved system of lighting and heating railway vehicles by electricity." M. Moskowitz, L. D. Adler, A. S. Adler, and T. W. Myers. Dated April 27th. (*Complete.*)

8,393. "Improvements in and relating to the electric lighting of railway vehicles." M. Moskowitz, L. D. Adler, A. S. Adler, and T. W. Myers. Dated April 27th. (*Complete.*)

8,394. "Improvements in means for equalising the electromotive force of dynamos." M. Moskowitz, L. D. Adler, A. S. Adler, and T. W. Myers. Dated April 27th. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1893.

21,714. "Improved electric exchange systems with apparatus therefor, applicable also for telegraphic and electric type-writing purposes." S. D. Williams. Dated November 14th. The object of this invention is to provide a new means of communication between renters, subscribers, or others connected either singly or through an exchange system. 11 claims.

22,053. "Improvements in or connected with so-called "dry" electrolytes for secondary batteries." V. C. Doubleday. (A communication from abroad by M. Sussmann, of Germany.) Dated November 17th. Consists in the application of specially prepared paper pulp or cellulose as a medium for producing a thick stiff paste or plastic compound, which, when used as an electrolyte in a secondary battery does not materially increase the internal resistance beyond that of a liquid one, and which, moreover, through its adhesive consistence has the advantage of efficiently protecting the battery plates inserted therein or packed between them. 2 claims.

1894.

3,641. "Improvements in ships' telegraph and indicating apparatus." T. Mudd. Dated February 20th. Consists in combining the telegraph gear in the engine room with the reversing gear of the engines in such a way that the ordinary dial of the telegraph shall indicate in the engine room the direction in which the engines are running. 4 claims.

11,280. "Improvements in jointing electric conductors." W. Geipel. Dated June 11th. Refers to joints which are contained in boxes made of metal, wood, pot, or otherwise, the main use of the joint being for concentric conductors which are, generally speaking, more difficult to joint than separate conductors. 3 claims.

11,601. "Improvements in printing telegraph instruments." O. L. Kleber. Dated June 14th. Consists of a systemised class arrangement of, and grouping of telegraphic signals consisting of dots and dashes with corresponding class groups of alphabetical letters, numeral characters, punctuation marks, and other intelligible signs in combination with an organised mechanism, whereby transmitted telegraphic signals are caused to produce, translate, singly and separately print such letters of the alphabet, numeral characters, and in such order as is required to form words and sentences at the opposite end of an electric line, corresponding and agreeing with messages sent or transmitted. 14 claims.

15,174. "An electrical rolling contact-making and breaking device." K. Ast. Dated August 8th. Relates to a contact-making device in which contact-making rollers of conducting material move over or under contact bars or rails formed of small pieces of metal separated from one another by pieces of insulating material, said metal pieces being connected together in such a manner that the circuit of a bell-operating battery is alternately opened and closed. 1 claim.

13,579. "Improvements in coin-controlled electrical apparatus." J. O. Frost. Dated December 30th, 1893. (Under International Convention.) Relates to an improved electrical apparatus which shall be constructed with a view to being active for a certain predetermined duration by the deposit of a coin on the proper part, so as to be available for use in giving shocks to the person dropping the coin into the machine, as well as for many other uses, including the regulation and supply of steam, water, &c., and in connection with any devices which could be operated by an external working circuit, which is active for a certain length of time. 4 claims.

17,365. "Improvements in clamps for raising and lowering electric or oil floor standards, also applicable for table lamps, music stands and the like." R W. Braham. Dated September 12th. Relates to clamps or grips for electric and other floor standards, table lamps, music stands and similar articles, and is designed to facilitate the raising and lowering of same without scratching and injuring the sliding rod or tube as is the case by the methods now at present in use. 1 claim.

17,846. "Improvements in electric arc lamps." J. Devonshire. (A communication from Elihu Thomson, of Massachusetts.) Dated September 19th. A derived circuit coil or magnet is employed acting against a retractor, such as a weight or spring and a feeding circuit comparatively independent in its feeding action but dependent for the times of action on the first magnet. 9 claims.

18,057. "An Improved carbon regulator for arc lamps." L. Zausmer. Dated September 22nd. Refers to a pneumatic automatic adjustment of the carbon pencils employed in arc electric lamps, and is designed to supply a simple and effective mode of keeping them in contiguity in all states of the weather. 2 claims.

18,288. "Improvements in secondary or storage batteries." C. Riordon. Dated September 26th. Consists essentially, first, of constructing each electrode of a plurality of plates of lead, aluminium, or other suitable material, arranged horizontally with alternate layers of oxide between them, and connected together at the end by a suitable saddle, attached to or forming part of the binding post; secondly, of providing a top and bottom plate of rubber for each electrode, with suitable laterally extending lugs, through which extend hard rubber bolts, which bind the electrode together; and thirdly, of providing springs, preferably of rubber, beneath the tightening nuts on the top of the bolts of each electrode. 7 claims.

18,339. "Improvements in and connected with carbons for electric lamps or for other purposes." E. G. Acheson. Dated September 27th. Consists in a carbon or filament composed essentially of carbon, having associated with it and forming a part thereof, a certain proportion of carbide of silicon. 3 claims.

18,910. "Improvements in and relating to vessels for electrolytical purposes." P. Jensen. (A communication from abroad by H. Cappelen and D. Cappelen, of Norway.) Dated October 5th. Claims:—1. The application and use as a coating medium for wooden vessels used for electrolytical purposes for protecting the wood against the influence of electrolytical processes and rendering it impervious to liquids and gases and non-conducting to electricity; of an intimate mixture of water-glass and black japan (or other suitable asphalt composition), the latter exceeding in quantity. The manufacture and use of wooden electrolytical vessels coated inside, and it may be also outside, with a mixture as firstly claimed.

19,185. "Improvements in electric switches or circuit breakers." F. Stevens and R. R. Kesteven. Dated October 9th. Has for its object to provide a simple, cheap, and effective switch, which may be applied and used in a house or room without disfigurement, and which shall insure the complete making or breaking of the circuit when operated. 1 claim.

19,186. "Improvements in electric thermostatic fire alarms." L. G. Rowand. Dated October 9th. Its main object is to construct a thermostat of simple character, which will have all its working parts protected and not liable to derangement, and which may be readily readjusted in position after the sounding of an alarm. 3 claims.

19,191. "Improved means for securing the conducting wire to the carbon electrode in elements of galvanic batteries." F. A. von Alimonda and N. von Alimonda. Dated October 9th. The lower end of the wire is bent at right angles and projects either into the carbon or into the lug affixed to the latter, whereas the vertical portion of the wire is embedded in a groove preventing any lateral deviation. 1 claim.

19,517. "An improved apparatus for indicating the lamp-hours of electric lamps." R. Wende. Dated October 13th. Claim:—An apparatus for indicating the lamp-hours of electric lamps, comprising a clock mechanism whose escapement-wheel can be liberated or stopped by a pawl moved by the contact-device of the light-conductor by means of an eccentric.

19,742. "Improvements in electrical switches." W. P. Theermann. Dated October 17th. Claim:—The combination of an oscillating switch block a spring stop acting on inclined retaining surfaces and terminals taking against the flat side of the switch block, substantially as and for the purpose set forth.

21,347. "Improvements in systems of telegraphic or telephonic exchanges." W. Childs. Dated November 6th. The object of the invention is to provide improved switching means for automatically making connections between the subscribers' telegraphs, or telephones, and disconnecting the same without the services of operators or attendants at said central office. 5 claims.